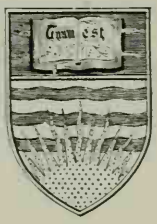

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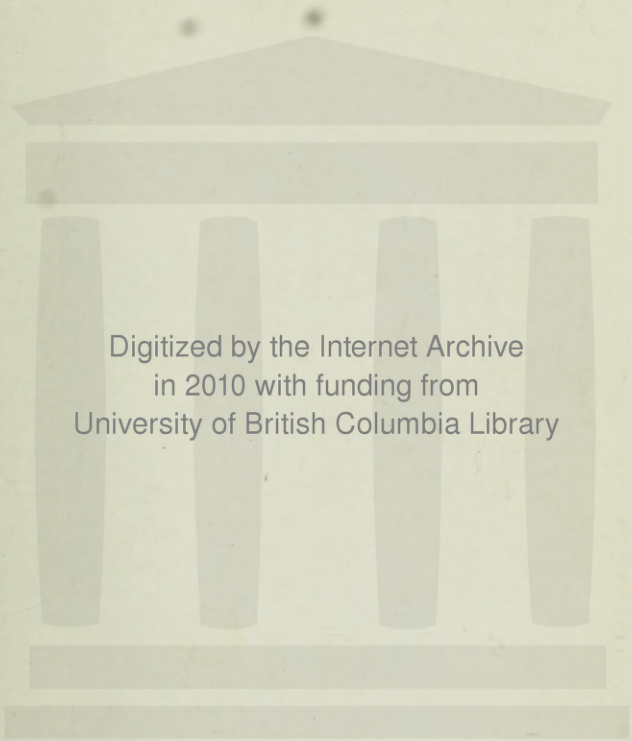
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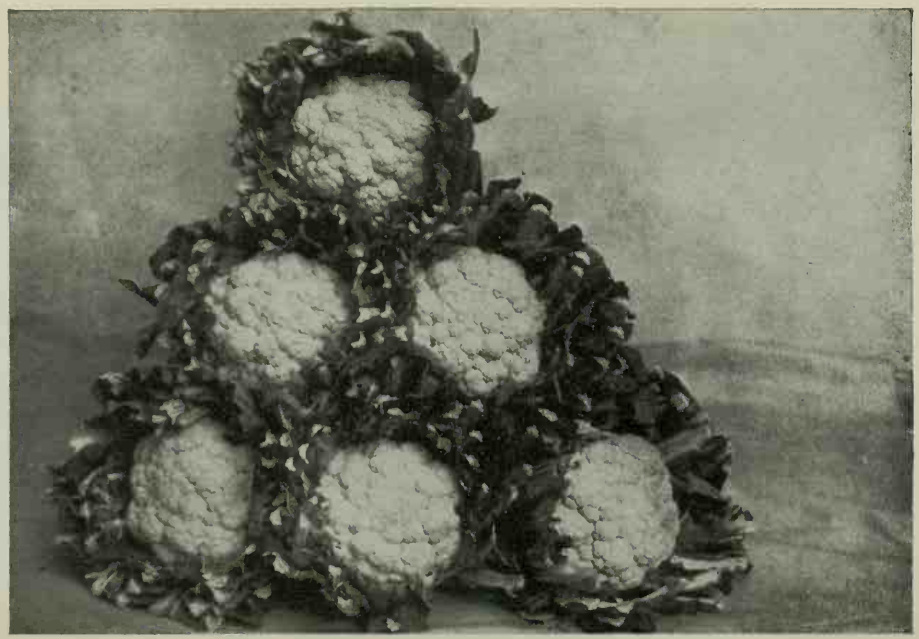

PERFECT HEADS OF CAULIFLOWER.

They are pure white, well formed, compact and of desirable market size. Their unblemished appearance and uniformity add to their attractiveness and salability.

Cauliflower and Broccoli Culture

Principles and Practices involved in the Growing and Marketing of these important Vegetables including Soil and Climatic requirements, Soil Management, Plant Growing, Pest Control, Marketing, Yields and Values, Production Costs, Varieties, and Seed Growing.

By A. G. B. BOUQUET

Professor of Vegetable Gardening, Oregon State Agricultural College

ILLUSTRATED

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INTRODUCTION

In the preparation of the Garden Series we have endeavored to secure the services of a highly qualified specialist to discuss each crop.

We were fortunate in enlisting the interest of Mr. A. G. B. Bouquet, Professor of Vegetable Gardening at the Oregon State Agricultural College, to prepare the treatise on Cauliflower and Broccoli. For more than a decade he has lived in the West where he has studied every detail involved in the production and marketing of these crops. Hence, he has acquired an intimate acquaintance with the numerous problems relating to soil preparation, seed strains, maturity tests, and harvesting. He also has given special attention to the marketing of the crops.

In this volume the results of Professor Bouquet's studies are made available to growers and prospective growers and they are fortunate in having such an instructive guide, prepared by a national authority on both cauliflower and broccoli.

R. L. Watts
Editor

State College,
Pennsylvania

PREFACE

THE vegetable gardening industry comprises the growing and marketing of some forty vegetables, each of which requires its own peculiar conditions for growth and methods of culture to attain best development.

In recent years the branch of vegetable growing called truck farming, namely, the production of specialty crops, has been increasing rapidly. Beginning with comparatively small acreages but a few years ago, many parts of the country are now engaged in crop specialization, shipping yearly many hundreds of carloads. Among these crops are cauliflower and broccoli, two vegetables intimately related and differing chiefly only in the season of the year at which they are harvested. The production of these vegetables is not confined to the crop specialist. For each one, particularly cauliflower, may be included in the list of crops grown by the market gardener and the home gardener.

It is being realized more every year that each vegetable has distinct preferences for suitable climatic, soil, and general cultural conditions that enable the crop to reach its finest growth. Not the least exacting of vegetables in this regard are cauliflower and broccoli, the successful culture of which demands peculiar consideration and care on the part of the grower.

In this brief treatise there has been no attempt to lay down a golden rule to be followed in all practices and yet the author has sought to bring together in a simple form recommendations for carrying out certain modes of operating based as far as possible on efficient present day methods. Systematic ways of farming are just as important in agriculture as in other industries. On the other hand, it is fully realized that there are many variable factors and conditions entering into crop production and marketing which are governed largely by the gardener's individual location, soil and climatic conditions, and individual preferences for carrying out certain phases of the work, which can not be prescribed for in any educational reference.

In the production of any one vegetable, and particularly for the future prosperity of those growers producing specialty crops, quality of the product is the watchword and the basis of success. In order to obtain quality one must observe rather closely the particular requirements of the crop and follow the most approved practices of growing and marketing.

With these considerations in mind, therefore, the author submits the following pages of suggestions and recommendations in the hope that they may prove of benefit.

A. G. B. Bouquet

Oregon State
Agricultural College

CONTENTS

CHAPTER		PAGE
	INTRODUCTION	v
	PREFACE	vii
	LIST OF ILLUSTRATIONS	x
	ACKNOWLEDGMENTS	xii
	PART I—CAULIFLOWER	
I.	ORIGIN AND DEVELOPMENT	15
II.	CAULIFLOWER AS A CROP PLANT	20
III.	ADAPTATION TO CLIMATE AND SOIL	27
IV.	SOIL FERTILIZATION AND MANAGEMENT	33
V.	PLANT GROWING AND SETTING	43
VI.	INSECTS AND DISEASES	55
VII.	PREPARATION FOR MARKET	67
VIII.	YIELDS, COSTS, AND VALUES	81
IX.	CROP MOVEMENTS	87
X.	SEED VARIETIES AND STRAINS	89
	PART II—BROCCOLI	
I.	HISTORICAL DEVELOPMENT	95
II.	RELATION TO CLIMATE AND SOIL	97
III.	PLANT GROWING AND TRANSPLANTING	103
IV.	PREPARATION FOR MARKET AND MARKETING	109
V.	YIELDS, VALUES, COSTS, AND CROP MOVEMENTS	114
VI.	VARIETIES, STRAINS, AND SEED GROWING	116
VII.	REFERENCES	122
	INDEX	124

ILLUSTRATIONS

PLATE		FACING PAGE
	PERFECT HEADS OF CAULIFLOWER . *Frontispiece* They are pure white, well formed, compact and of desirable market size.	
I.	DESIRABLE TYPE OF CAULIFLOWER PLANT Showing typical outer leaf characters and incurving jacket leaves protecting the compact head. Large head on left, smaller head more closely stripped on right.	16
II.	CAULIFLOWER PLANT BEDS FOR MAIN CROP . . . . . . Located near fields to be set. Plants on right several days older than the smaller plants. Rows 14 inches apart.	17
III.	SETTING PLANTS IN THE FIELD . . . *Above*—Preparation of plants before being taken to field. They have been graded and leaf-trimmed. *Below*—Horse-drawn transplanting machine setting several acres a day.	32
IV.	PLANTS TIED FOR HEAD PROTECTION . . *Above*—Operator tying plants with twine to prevent discoloration of embryo heads. *Below*—Plants tied must be watched closely as development of heads after tying is rapid.	33
V.	GOOD AND POOR HEADS FOR PACKING . *Above*—Left, head over mature and blemished; center, over mature; right, blemishes spoil otherwise good head. *Below*—Three grades of heads, left, ricey; middle, slightly overmature; right, excellent.	48

VI. Cauliflower Packing and Inspection 49
Above—Typical pack of western pony crate—widely used container holding average of 10-12 heads. See Chapter VII.
Below—Federal inspector examining stock at shipping point.

VII. Loading Cars for Shipment 80
Of various methods in use, this is the alternate loading of 4 and 5 wide; ice blocks in pigeon holes as well as on top of load.

VIII. Broccoli Land Must be Well Drained 81
Portion of this field (in foreground) was low and poorly drained. Investment in drain tile would have returned a high interest. Land both on left and right of view higher and well drained.

IX. Field of Seed Strain Trials 96
With both cauliflower and broccoli preseason tests of various seed strains are desirable and in many cases practised in commercial crop production areas.

X. Broccoli Plant and Head for Seed Growing 97
Above—True type of plant selected showing character of leaves and head in first stages of segmentation.
Below—Head tied for protection against crossing with other crucifers.

ACKNOWLEDGMENTS

MANY courtesies and much information of value have been received by the writer from federal, state, and county agricultural workers to whom singly and collectively sincere thanks are due. Frequent excerpts from state bulletins dealing with the crops in hand have been included in the manuscript and the use of these is greatly appreciated. The authors of these references are listed on pages 122 and 123 of this volume.

Many of the photographs have been made in fields of commercial growers whose interest, cooperation, and helpfulness along these lines, as well as in other features of the discussion, could hardly be sufficiently defined in words of thanks.

PART I

CAULIFLOWER

I. Desirable Type of Cauliflower Plant.

Showing typical outer leaf characters and incurving jacket leaves protecting the compact head. Large head on left, smaller head more closely stripped on right.

II. Cauliflower Plant Beds for Main Crop.

Located near fields to be set. Plants on right several days older than the smaller plants. Rows 14 inches apart.

CAULIFLOWER

I

ORIGIN AND DEVELOPMENT

CAULIFLOWER, as an herbaceous plant, is regarded generally as one of the "aristocrats" of the vegetable garden. It has been said more or less truly that the test of a good gardener is revealed in his or her ability to grow cauliflower. Certain it is that this vegetable is exacting in its requirements of the best conditions for crop production and marketing.

The present day perfection of this distinctive and refined vegetable is far removed from the ancient type, and its development presents an interesting story in horticultural literature.

Origin and History—Cauliflower is a member of the Brassica family and is known botanically by the name of Brassica oleracea botrytis cauliflora De C. The Brassicas had their origin in the coasts of England and Wales, the Channel Islands, and Southern Europe. Innumerable sorts have arisen under cultivation, says Henslow, so that roots, stems, branches, and unexpanded inflorescences have been bred. Included in the last grouping, the cauliflower and broccoli plants supply masses of hypertrophied inflorescences.

Statements regarding the exact origin of the plant seem to be somewhat conflicting. Sturtevant mentions that he is unable to recognize the cauliflower in any of the cabbage tribe described by the ancient authors, although the perfected conditions of the present vegetable would lead him to assign to it great antiquity. Other writers claim the plant has been under cultivation since before the Christian era and that it was apparently well known to the Greeks and Romans, at least in cruder forms. Pickering states that cauliflower was first mentioned in 540 B.C. It is said to have come to Europe via Venice and Antwerp. The Moors of Spain are stated to have written about it in the 12th century, having received it about that time from Syria. It was mentioned in the French edition of Dodoneaus in 1553.

In the English name used by Lyte in 1586 the source of origin is indicated as it was called "Cypress coleworts" or "cabbage of Cyprus," probably referring to the place where the seed was grown. In England it was figured by Gerard in 1597, and it was a well known and carefully cultivated plant in France in 1612.

In 1806, in America, McMahon mentions early and late varieties and so does Bridgeman in 1832. Three varieties were named in 1824 in France. Later on Burr described 10 sorts in 1836 and Vilmorin described 16 kinds in 1883.

Development—In the different varieties of Brassicas known as cauliflower it is the flower

stem which has been modified in size and appearance in the course of cultivation. The flowers themselves have been rendered abortive, and the branchlets, along which they grow, gaining in thickness what they lose in length, form a sort of regular corymb with a white fleece-like surface which is barely broken by a few leaves growing through it. The floral branchlets have become large, white, thick, and tender. The shoots are nothing but a homogeneous mass and the rudiments of the flowers are represented only by the minute and almost imperceptible prominences found in the upper surface of what is called the "curd," "flower," "coral" or head of the cauliflower plants. Henslow again remarks, "The sprouting or asparagus broccoli represents the first form exhibited by the new vegetable when it ceased to be the earliest cabbage. After this, by continued selection and successive improvement, varieties were still further improved into kinds which are sufficiently early to commence and complete growth in the course of the same year. These last named kinds are now known by the name of cauliflower."

In recent years the solid compact white curd not only has been maintained and improved but a notable development has been shown in the tight formation of the head leaves over and about the curd, thus naturally protecting it from discoloration.

The Plant and Its Parts

Cauliflower has a large branching root system with many laterals and a network of smaller roots that extend 2 to 3 feet in depth and 2 to 2½ feet on all sides of the plant.

The stem above ground is thick and short being from 1 to 1½ inches in diameter and 6 inches long. It is quite susceptible to injury by frequent frosts and the pith when injured causes a hollowness of the stem which may or may not affect the formation of the curd.

The leaves of the cauliflower plant are commonly long and narrow, typical Snowball leaves of average size being 27 to 30 inches long and 9 to 12 inches at the widest diameter. They are curved both inward and outward but are generally flat. Well grown plants have over 40 leaves, exclusive of about 12 leaves which form the head protection.

The foliage of the plant in proportion of weight to the head is about 2 or 3 to 1, plants having 7 to 7½ pounds of total leaves bearing heads weighing 2½ to 3 pounds trimmed. Smaller types of cauliflower have a less amount of foliage weight.

The curd or head may be flat or globular-flat with any variations between these shapes. Deep heads, tending to be globular, have greater weight. The general outline of a good head should be round and regular. Heads of desirable

market size are from 4½ to 6½ inches in diameter.

The seed stalks are tall, growing to a height of 3½-4 feet. The seeds are small, brownish black, irregularly round, and number approximately 10,250 per ounce. They have a longevity of about four years.

Growers are united in the belief that it is better to plant seed at least one year old instead of new seed. Evidence is at hand showing that the foliage of plants grown from new seed is heavier than that of plants produced from one-year old seed. In certain instances observed the plants with the larger foliage grown from new seed had a tendency to produce heads that were smaller in size and sometimes of inferior quality, solidity, and curd formation.

II

CAULIFLOWER AS A CROP PLANT

Cauliflower has an important place in the operation of a home garden. The home gardener takes particular pride in growing fine, white cauliflower heads. Many home gardeners do not raise this vegetable because of the somewhat exacting requirements of the crop, its susceptibility to suffer through unfavorable soil and weather conditions, and the tendency to "buttoning," or formation of a small head, before normal plant growth has taken place.

Among the various vegetables grown in the market garden, cauliflower fits in very well as a crop that usually brings good returns. The fall crop can be grown so as to succeed spring vegetables, such as peas, lettuce, or spinach. The spring crop may be followed by celery, late sweet corn, fall lettuce, or spinach.

The greatest development and increase of business in recent years, however, has been along truck farming lines, namely, in the shipments of straight or mixed carloads of cauliflower to distant markets.

Commercial Importance

In point of actual acreage of important vegetable crops, cauliflower ranks fifteenth. In money

TABLE I.—CAULIFLOWER—COMMERCIAL CROP

ACREAGE, PRODUCTION, AND PRICE PER CRATE, BY STATES, 1925-1928[1]

STATE	Acreage				Production				Price per crate			
	1924-25	1925-26	1926-27	1927-28	1924-25	1925-26	1926-27	1927-28	1924-25	1925-26	1926-27	1927-28
	Acres	Acres	Acres	Acres	1,000 crates	1,000 crates	1,000 crates	1,000 crates	Dollars	Dollars	Dollars	Dollars
California[2]	6,610	10,500	8,950	12,800	2,148	3,224	2,452	3,558	1.11	.88	1.00	0.84
Colorado	1,000	1,100	1,160	1,700	160	99	336	510	.71	1.15	1.78	2.25
New Jersey	400	300	300	200	52	44	45	26	1.38	1.15	1.50	1.50
New York	5,530	5,560	5,060	4,320	713	1,334	794	557	1.55	1.36	1.83	1.64
Oregon[3]	1,600	5,000	2,100	1,360	320	825	420	292	1.05	.69	1.18	1.19
Utah	40	60	180	270	10	12	49	44	2.50	2.00	2.00	1.66
Total	15,180	22,520	17,750	20,650	3,403	5,538	4,096	4,987	1.19	.98	1.26	1.10

[1] Bureau of Agricultural Economics. Estimates based upon returns from crop reporters.

[2] Average for season.

[3] Season of California and Oregon begins in October of the previous year.

value per acre, however, its standing is much higher, probably fifth or sixth.

While numerous states grow cauliflower as a market garden crop, comparatively few states produce it widely as a truck crop for car shipments. Whereas 33 states grow tomatoes widely, only five have fairly large areas of cauliflower for shipment.

The industry on Long Island, N. Y., began in 1874 and has since thrived, New York State now having the second largest acreage in the country. The important cauliflower-growing counties of New York are Suffolk, Erie, and Delaware. California, the foremost shipping State, made its initial shipment in 1894 but the greatest increase in business occurred from 1915-1921, and since that time the rate of increase has declined somewhat. Seventy percent of the total U. S. shipments of cauliflower come from California which grows the crop in northern, central, and southern counties. Other western states, including Oregon and Colorado, have but recently developed a shipping business up to present proportions.

Improved methods of icing cars have been largely responsible for the successful transportation of Western cauliflower to Eastern points, hence, the increase in acreage in certain States adapted to the growing of cauliflower.

Cauliflower is not so widely consumed pound for pound as other vegetables, because it is more costly on the open market. The comparatively high retail price frequently existing is often a

TABLE II.—CAR-LOT SHIPMENTS OF CAULIFLOWER AND BROCCOLI BY STATE OF ORIGIN, 1920-1928 *

Crop Movement Season—July 1-June 30 of following year.

STATE	*1920-1*	*1921-2*	*1922-3*	*1923-4*	*1924-5*	*1925-6*	*1926-7*	*1927-8*	*1928-9*
Arizona						5			58
California	2,957	3,629	3,604	3,054	3,404	4,356	4,730	7,018	6,768
Colorado		3	4	101	61	191	220	411	843
Idaho			3	3	2	2			
Illinois		1				4			
Michigan	2	4	1	34	67				
Minnesota		5	3	18	6	21	13	13	
New Mexico	7			8	36	18			
New Jersey						2			
New York	781	567	683	653	734	834	1,019	696	574
Oregon	83	134	282	374	333	1,246	780	574	501
Texas				2	3	1	43	57	155
Utah			1		3	6	12	172	159
Virginia	14	15	13	37	14	30	7	6	
Washington				1	2	9	47	49	31
Others	9	5	14	18		2	21	60	53
Total	3,853	4,363	4,608	4,303	4,665	6,727	6,892	9,056	9,133

* Bureau of Agricultural Economics, subject to revision.

hindrance to extensive market sales. Its handsome white color, however, tends to make it an attraction on the market and, where offered for sale in an unblemished white appearance, it moves readily even at rather a high figure. Heads that are spread, dirty, spotted, or over-mature are a hindrance to consumption. At a reasonable f.o.b. price per crate cauliflower should move at a moderate retail figure. Gradual increase in production is taking place and the crop is being distributed more widely.

The future of the cauliflower industry rests largely with the grower in his efforts to place on the market a product of unblemished appearance and high quality.

Cauliflower as a Forcing Crop

Due to the development of the outdoor growing of cauliflower in certain parts of the country at different seasons of the year, the forcing of the vegetable under glass has not become nearly as important as that of other crops. It is forced to some extent, however, near many of the larger centers of population and according to Watts [1] greenhouses that are managed properly should pay satisfactory profits with cauliflower. The crop may be used as a possible substitute for lettuce. Prices for the forced article probably would depend to a great extent on the amount of outdoor stock rolling and the prices paid for it.

Watts [1] recommends that the crop be grown in ground beds, from as high grade of seed as

[1] Watts, R. L., Vegetable Forcing, Chap. XV.

possible of the varieties Erfurt or Snowball. The soil must be fertilized heavily, both manure and a high grade commercial fertilizer being used. The crop is usually grown under glass during the winter and early spring months, requiring approximately four months from seed sowing to harvest. The temperature maintained is slightly higher than for lettuce. The green aphis is the most common pest readily controlled by tobacco fumigation. Heads must be covered for protection as in outdoor culture. Prices for good heads average from $2.00 to $2.50 per dozen and the return per square foot of greenhouse area is estimated at 12-15 cents.

Cauliflower is also grown in frames both as a fall and spring crop.

Cauliflower for Manufacture

Comparatively little data is at hand concerning the actual amount of cauliflower used by factories for pickling. A partial report [2] by pickle manufacturers of the acreage planted for this purpose is as follows:

	Acres 1926	*Acres 1927*
Colorado	29	66
Michigan	608	682
New York	267	263
Wisconsin	43	157

Cauliflower heads that cannot be packed in No. 1 or No. 2 grade may be suitable for pickling provided they are white, clean, and unwilted.

[2] Report furnished by National Canners Association, Washington, D. C.

Heads that are over mature and have begun to segment can be used if they meet the requirements above named.

Prices paid to growers for cauliflower heads trimmed of leaves delivered at the factory range from $20.00 to $30.00 per ton.

Table Value

Cauliflower has always been considered a table delicacy. Its white color and tenderness make it an especially attractive dish, and there is every reason to believe that it will continue to be increasingly popular and that it will be used more widely.

From a nutrient standpoint, it cannot be classed as high as some other vegetables, having the following analysis:

Water	*Total Nutrients*	*Protein*	*Fat*	*Carbohydrates*	*Mineral Matter*	*Potential Energy in 1 lb.*
90.8	9.2	1.6	.8	5.0	.8	155 Cal.

Of the mineral compounds in cauliflower are sodium, potassium, calcium, magnesium, and iron. Cauliflower also contains amides and citrates which exercise important healthful influences in the body. It is one of the most rapidly digested of vegetables.

It is a dish which is much more common in Europe than in this country where it is not yet appreciated as it should be.

III

ADAPTATION TO CLIMATE

CAULIFLOWER is more exacting in its climatic requirements than the other Brassicas. It grows to best advantage under comparatively cool temperatures, with a moist atmosphere preferred. This is exemplified by the fact that areas bordering bodies of water, where naturally cool conditions prevail, are widely used for commercial production. Arid atmospheres, intense sunshine, and dry winds are entirely unfavorable for cauliflower.

Long Island is particularly well situated, due to the influence of the ocean, in inducing a good development of the plant and extending the fall harvesting season. Oregon has a comparatively mild summer and a cool, moist autumn, with delayed frosts. Warm days and cool nights prevail in the high altitudes of Colorado. A good deal of the areas of production in California are in the coastal counties, where the temperature is uniformly cool, but the crop is quite evenly distributed over the entire state according to seasons of the year.

The plant is sensitive to checks in growth due to unfavorable conditions, such as unusually hot weather, drought, too low temperature. Forma-

tion of premature heads, termed "buttoning," may often result from these conditions. Well distributed rainfall during the season is a valuable asset, otherwise it may be necessary to irrigate.

Dry spring weather may be a serious factor in decreasing the amount of plant growth. Cloudy conditions are most favorable for transplanting plants into the field. Heads in process of forming may be protected from light frosts by being covered by outside leaves as in blanching. Hot weather toward the time of maturity is undesirable, as it causes the heads to develop too rapidly. Cool areas of production are valuable, therefore, in that the crop does not mature so rapidly and can be harvested to better advantage.

Cool, wet weather may often prevail during the season of harvesting, but if the heads are well protected, either naturally or artificially, they will not particularly suffer. Early fall frosts often reap a heavy loss. Delayed autumn frosts, with moist weather, permit an extended harvesting season.

Peculiar formations and characters of the cauliflower heads such as "riceyness" and "fuzziness" may oftentimes be induced by unfavorable weather conditions.

Relation to Soil

Cauliflower is grown successfully on a number of different types of soils varying largely according to the areas where it is produced. The plant is one that naturally reacts adversely from the

effect of unfavorable growing conditions among which soil texture and fertility constitute most important factors; hence the necessity for paying particular attention to soil characters.

In general, cauliflower grows to best advantage in a rich loamy soil that is capable of holding moisture well. If the plants are not to be irrigated, the water holding capacity of the soil is an important character particularly in areas where the summer and early fall precipitation is light. Ample soil moisture is necessary, not only at transplanting time but throughout the entire growth of the plant. Reference has already been made to the danger of checks in growth due to a low water table.

A high humus content of the soil, therefore, is desirable for holding moisture as well as for providing better aeration and water penetration. It also gives bulk to the lighter soils and tends to loosen up the heavier ones. If the organic matter content is naturally low, it may be supplied by stable or green manures as discussed in future paragraphs.

Inasmuch as considerable cauliflower is harvested in the fall, the soil should be well drained. This is particularly necessary with the clay loam types and muck lands. Naturally rolling land will have good drainage and in many instances be useful for irrigation if the slopes are gradual.

Sandy and silty loams are most widely used, varying considerably in their texture. Long Island soil types are largely sandy loam of mod-

erate fertility. Gravelly and silty loams are used in Erie County. Cauliflower is also successfully grown on drained muck land. In Colorado a deep rich loamy type is preferred, with a high percentage of organic matter either naturally present or artificially provided. California growers use different types of soils for cauliflower, varying from the sandy or silty soils, which are irrigated, to medium and heavy types useful for varieties that mature in the fall and spring. Very light soils are undesirable, unless they can be irrigated, and even then they should, if possible, be well supplied with manures to increase their water holding capacity. Oregon soils used in cauliflower growing are largely of a light brown loam texture, mellow, friable, retentive of moisture, naturally rolling, and moderately high in organic matter. Analyses of such soils producing fine cauliflower are here given.

Analyses of Soil Types Used in Cauliflower Growing

	Fine Gravel	*Coarse Sand*	*Med. Sand*	*Fine Sand*	*V.F. Sand*	*Silt*	*Clay*
Type 1 ...	1.4	2.5	1.0	7.5	29.0	45.9	12.7
Type 2 ...	0.0	0.5	0.8	4.1	33.0	49.3	12.3

Note.—Type 1 is Hillsboro loam; type 2, Powell loam, both western Oregon soils.

Cultivation is necessary for (1) preventing weed growth and soil baking and packing, (2) conserving soil moisture, (3) maintaining a loose mellow mulch, (4) encouraging deeper rooting of the plant, (5) assisting in making fertilizer avail-

able. The depth of cultivation is an important consideration. The plant when grown has a vigorous and extensive root system, extending to a depth of 2-3 feet and 2-2.5 feet on all sides. Cultivations in general should be shallow—deeper, perhaps, when the plants are young and shallower as they increase in size. Cases have been reported wherein severe damage to shallow feeding roots has occurred, due to deep cultivation late in the season as the plants approached maturity. Late cultivations, therefore, unless shallow, might do more harm than good.

Five and seven-toothed cultivators are satisfactory and they should be set to work just as soon as the plants are established following the transplanting, and the work repeated at general intervals, possibly four to six cultivations during the season. Cultivation should at least be continued as long as weeds need to be eliminated and moisture conserved and the operator can pass between the rows.

One or two hoeings may be necessary to remove weeds around the plants and to get at soil untouched by the cultivator. The number of hoeings will depend on the spacing of the plants and the efficient work of the cultivator.

Irrigation

Irrigation is necessary in cauliflower production in the southern states. It may also be used to considerable advantage in some of the northern

areas. It is particularly useful to the market gardener in providing soil moisture for the spring and early summer crops of cauliflower and in the setting of plants for the main crop.

Methods of applying water to cauliflower fields vary according to: (1) size of acreage; (2) lay of land; (3) section of the country. There are two general methods of irrigation: the overhead pipe or sprinkling system, and the furrow method or gravity system.

The sprinkling system is in wide use by market gardeners growing cauliflower in a rotation of crops, and smaller areas of land are often watered by the overhead pipe method. This system is valuable at transplanting time and thereafter whenever the soil shows signs of becoming dry. The soil is moistened uniformly, so that the plants may make a gradual, uniform growth.

Furrow irrigations are more adapted to larger acreages in districts where cauliflower is grown as a truck crop, particularly in the western sections. In such areas as Colorado and California irrigations are given immediately after plant setting has taken place or as soon as the plants are established.

Southern California growers usually figure on about five irrigations for the season. Where the plants are small the water is run close to the row, the furrows being further from the row as the plants increase in size.

III. Setting Plants in the Field.

Above—Preparation of plants before being taken to field. They have been graded and leaf-trimmed.

Below—Horse-drawn transplanting machine setting several acres a day.

IV. Plants Tied for Head Protection.

Above—Operator tying plants with twine to prevent discoloration of embryo heads.

Below—Plants tied must be watched closely as development of heads after tying is rapid.

IV

SOIL FERTILIZATION AND MANAGEMENT

THE object of the cauliflower grower, in considering a program of soil fertilization, is to grow plants of sufficient vigor that will produce a uniform lot of heads of the most desirable size. It is generally conceded that medium to large plants are necessary to bear good sized curds, hence the soil is usually quite heavily fertilized. Land that is "thin" or impoverished will produce small plants and in consequence small heads. The experience of growers seem to justify a liberal fertilizing program for cauliflower as the plants are heavy feeders and thrive in rich soil.

It is seldom that a field is so overfertilized that ill results will occur, although cases of so-called "malnutrition" troubles have been reported, usually occurring where large amounts of commercial fertilizers were used.

CROP CONSTITUENTS

The table on page 34 shows the makeup of a normal crop yield.

Nitrogen—A study of Table III indicates the particular importance of nitrogen in both leaves and heads. A vigorous foliage growth is desired for the production of a good marketable head as

TABLE III.—POUNDS OF FERTILIZER FOUND IN CAULIFLOWER FROM 1 ACRE. *—5-TON YIELD

	Heads Pounds	*Leaves Pounds*	*Roots Pounds*	*Total Pounds*
Nitrogen	33.9	63.8	18.8	116.5
Phosphoric Acid	10.2	18.4	7.9	36.5
Potash	24.5	39.4	24.4	88.3
Lime	6.7	70.4	17.2	94.3

* R. Harcourt: Annual Report Ontario Agric. College, 1910.

DRY MATTER IN DIFFERENT PARTS OF MATURE CAULIFLOWER PLANT

COMPONENTS	*Heads percent*	*Leaves percent*	*Roots percent*
Water	93.16	91.09	85.07
Dry Matter	6.84	8.90	14.93

well as for the protection of the same against unfavorable weather conditions. Jones and Ernst observe in California that "in general, growers have found that it is the lack of nitrogen which limits the growth of the cauliflower plant. Nitrogeneous fertilizers, therefore, usually give the greatest growth response."

Too strong a vegetative growth of the plant, however, may often result in a disturbance of the compact formation of the head, there being a tendency toward a more leafy and loosely forming curd when the plants are unduly vigorous.

Phosphorus—While this constituent is the lowest in Table III it is nevertheless important in the makeup and general vigour of the plant. Earlier maturity of the heads seems to be induced by ap-

plications of phosphorus-furnishing materials which are generally used in combination with some form of potash fertilizers. Phosphate fertilizers, applied alone, do not seem as satisfactory as the mixture of phosphorus and potash carrying materials. The phosphorus-furnishing materials are the least costly of any contained in the mixed fertilizer.

Potash is an important element in both leaves and heads of the cauliflower and therefore it is considered to be essential in the formula of a commercial fertilizer. While no definite experimental data is in evidence, the experiences of growers point to the particular value of potash as a factor in improving the solidity and shipping qualities of the head, as well as tending towards earlier maturity.

Materials used in applying plant food include (1) stable manures; (2) green manures; (3) crop remnants; (4) crop rotations; (5) commercial fertilizers.

Stable manures furnish valuable organic material as well as a balanced fertilizer. Twenty tons of manure would furnish 200 pounds of nitrogen, 120 pounds of phosphoric acid and 200 pounds of potassium oxide. Where manure is available at a reasonable figure laid down on the land it is invariably used. Light soils are particularly benefited by the addition of manure. Well rotted manure is best for application preceding the setting of plants. Fresh straw manure is seldom if ever used. A common time to apply

manure is during the spring soil preparation, except in the case of an annual rotation of crops in which event the manure may be applied the year previous to growing the cauliflower. In cases where cauliflower is a market garden crop manure may be applied early in the spring to care for both the first crop preceding the cauliflower as well as the cauliflower itself.

A vigorous, uniformly dark green foliage of plants is commonly the result of the application of manure which is rarely applied in less quantities than 10 tons up to possibly 20 tons per acre.

Huber reports that manure alone to the extent of 10 and 20 tons, respectively per acre, did not furnish as satisfactory results in growing spring cauliflower in New Jersey as manure supplemented by 1000 pounds per acre of a complete fertilizer. Hartwell also finds this to be true. It seems probable therefore that a moderate amount of manure, 10 to 16 tons or so, supplemented by a complete fertilizer is desirable for a good yield of cauliflower.

Green manures are becoming more widely used because of the increasing scarcity of stable manure. Growers farming intensive, higher-priced land may not resort to green manuring as much as those engaged in more extensive growing of cauliflower as a truck crop. Green manures benefit the soil considerably in furnishing organic matter, although they take longer to decompose and furnish a smaller amount of plant food.

Crops used for green manures vary according to

the state in which they are planted. Vetch and oats, vetch and rye, and clover are common crops in the northwest. California growers use cowpeas, soy beans, and purple vetch. In New York state rye and clover are grown. These various crops are plowed under during the spring preparation of soil. County agents and other agricultural workers of the various states are in a position to make suggestions as to the best kinds of crops to be planted for green manures.

Crop Remnants—A considerable amount of foliage remains on cauliflower plants after harvesting, and this together with some trimmings at cutting time can be plowed under, adding to the organic matter furnished by the stable or green manures.

Crop rotations are valuable in assisting in the incorporation of humus into the soil. Due to the possible prevalence of club root as a persistent soil disease cauliflower is grown in several areas in a rotation of crops. A Long Island rotation may consist of potatoes or carrots preceding cauliflower, followed by corn, rye, wheat, or oats, after which the land may be in clover or grass for a year or two. Other rotations include corn after cauliflower, followed by grain, then by hay for two or three years. Some cauliflower growing areas, as yet experiencing no club root, can successfully grow the crop every year on the same ground.

Cover crops which supply humus are valuable

in a crop rotation either preceding or succeeding the cauliflower.

Commercial Fertilizers—Supplementary additions of fertilizers are frequently made by cauliflower growers to furnish an ample supply of available plant food. In fact, the use of commerical fertilizers is quite a general practice. The plant is one that must grow steadily from first to last with no check, hence, the use of quickly available fertilizers to maintain a constant growth.

If the soil is naturally fertile or has a high content of organic matter or is in a virgin state, commercial fertilizers may be used satisfactorily without manures. As a general rule, however, they are used in conjunction with the application of stable or green manures.

Nitrogen-furnishing materials are divided into two classes: first, inorganic and quickly available, including nitrate of soda and sulphate of ammonia; second, organic and more slowly available, consisting of tankage, fish meal, dried blood, and cotton seed meal.

The inorganic materials are nearly always found in fertilizers carrying nitrogen, at least one-half the nitrogen being from this source. DeBaun reports the yield as being increased by nitrate of soda alone, but prefers a fertilizer also carrying potash. Lloyd states that in treating cauliflower over a period of six years with nitrate of soda, applied once in two weeks, this fertilizer was more economical and gave better yields than

an application once a week, both applications being superior in point of producing good heads than the untreated cauliflower. In addition to being included in a complete fertilizer, either nitrate of soda or sulphate of ammonia is used in side dressings, at the rate of 100 or 150 pounds per acre.

The organic materials furnish more slowly available nitrogen and are used in conjunction with the quickly available material, usually at the rate of 3 to 500 pounds per acre, depending upon their analysis.

Phosphatic fertilizers are supplied by: (1) super-phosphate, inorganic and quickly soluble; and (2) bone meal, organic and more slowly available. Either of these might be used in a complete fertilizer, although there is a greater tendency toward the inclusion of the acid phosphate rather than the bone. The former may be used at the rate of from 500 to 1000 pounds per acre, and the bone meal in amounts varying from 400 to 700 pounds per acre.

Potash fertilizers are derived from muriate of potash and sulphate of potash, either of which may be used. The amount of these materials applied may vary from 150 to 300 pounds per acre.

Due to the variations of soils and general conditions existing in cauliflower fields in one state or another, no fixed rule can be laid down for the determination of the formula of a complete fertilizer which can be used. Recommendations along these lines are best made by experiment

stations and county agricultural agents in the individual states and counties where existing conditions are known and where experiments have possibly been conducted showing what materials and amounts may be used most economically and profitably.

The following recommendations have been made in the respective States where cauliflower is an important crop:

California—An application of 10 to 20 tons of manure is considered advisable. Nitrogenous fertilizers give the greatest growth response. Two hundred pounds of nitrate of soda or sulphate of ammonia, together with 200 to 300 pounds of tankage, fish meal, or blood meal per acre, applied before planting, should give good results. Side dressings of 100 to 150 pounds of nitrate of soda or sulphate of ammonia to the acre usually cause a quickening of the growth rate and a darkening of the leaves.

New York—Growers are justified in a fairly heavy fertilizing program. The lighter types of soil particularly need manure and a commercial fertilizer. Long Island practices include the use of one ton of 5-8-5 or 5-10-5 fertilizer applied during the spring preparation of the soil. Erie county growers use rotation of crops with 1000 pounds of complete fertilizer. Where no manure is used 1500 to 2000 pounds of 5-10-5 fertilizer are applied. For cauliflower grown on muck land, 1500 to 2000 pounds of 3-7-8 or 3-8-8 are used. Some malnutrition troubles have apparently been

caused where large amounts of commercial fertilizer have been used.

New Jersey—Manure and 1000 pounds of complete fertilizer give the best results in New Jersey on spring cauliflower. Acid phosphate alone was not satisfactory. Nitrate alone increased the yield but fertilizer carrying potash was more successful. Manure alone, in the amounts tested, namely 10 to 20 tons, did not furnish enough plant food for a good crop of cauliflower. Where the manure was supplemented with 1000 pounds of complete fertilizer together with the side dressings of nitrate of soda satisfactory results were obtained. Cauliflower responds to heavy fertilization and 2000 pounds per acre can be profitably used.

One side dressing of nitrate of soda applied three weeks after planting in connection with 1000 pounds of 4-8-4 gave increased yields and a second application applied two weeks after the first gave a still greater yield.

Oregon—Growers usually make manurial applications the year previous to growing the crop. Fertilizers used vary according to the individual grower. Combinations of 500 to 1000 pounds of superphosphate and 250 to 500 pounds of muriate of potash are common. A complete fertilizer analyzing 4-9-7 or 4-10-6 is used especially in cases where it is desired to include some nitrogen in the fertilizer.

Connecticut—Growers prefer a 4-8-4 formula using 1200 to 1500 pounds, supplementing 10 to

15 tons of manure or 2000 pounds per acre without manure. Two tons of limestone are also recommended.

Colorado—Twenty or more tons of manure per acre is a common application and this is often supplemented with chemical fertilizers.

Methods of Fertilizer Application include (1) broadcasting, (2) side dressing in the row, (3) local, to each plant.

Complete or incomplete fertilizers are invariably broadcast during the spring preparation of the soil. This is especially true in districts where no crop precedes the cauliflower. Where the rainfall is light during the late spring and summer months it is desirable to make the application when the land is being prepared in the spring. In irrigated areas the fertilizer may be broadcast at the time the soil is made ready for planting. The extensive root system of the plant indicates that under normal soil moisture conditions it is able to utilize economically the majority of the fertilizer that is broadcast. Extensive growers of cauliflower use the broadcasting method.

Where more intensive systems of farming are used the row method of application is adopted, particularly when additional dressings of nitrate of soda or sulphate of ammonia are made with fertilizer drills lengthwise of the rows.

Home gardeners sometimes make a local application to each plant using 2½ to 3½ ounces of complete fertilizer per plant or, if broadcasting, 6 to 8 pounds per square rod of garden area.

V

PLANT GROWING AND SETTING

Growing Plants for the Early Crop

While the greater part of the cauliflower acreage throughout the country is of the main or late crop maturing in the fall and early winter, yet early summer cauliflower is grown in some sections particularly by market gardeners rather than by truck growers in the shipping areas.

There are some definite drawbacks to the early crop, among which are the following: (1) susceptibility of the plants to peculiar or unfavorable spring weather conditions; (2) tendency for plants to become stunted and to produce "button" heads; (3) greater prevalence of maggot attacks both in the seed bed and field; (4) competition with other spring grown vegetables. The early crop is therefore considered more difficult to grow than the main crop.

The average spring weather conditions vary greatly, late frosts or sudden warm spells often occurring which tend to cause either "buttoning" or loose, open heads of comparatively little value. Maggots are more numerous in the spring or early summer than in the fall.

At the approach of warm weather cauliflower does not sell so readily, as there is a greater de-

mand for such vegetables as asparagus, rhubarb, peas, lettuce, tomatoes, etc.

Greenhouses or hotbeds are necessary in growing plants for the early crop. The plants are considerably more tender than those of cabbage and therefore the seeds should not be sown as early as they would be for early cabbage. Seed should be planted about March 1 to 10, allowing about seven to eight weeks for growth of seedlings before transplanting the latter part of April. About 8 to 10 seeds to the inch are planted in the greenhouse or hotbed soil. After the plants are two weeks old or have their third or fourth leaf established they should be transplanted or spotted to two inches apart. Cauliflower seedlings are unusually susceptible to the damping-off disease. This fungus can be controlled by soil sterilization with steam, hot water and formaldehyde, or any one of the commercial organic mercury preparations. Seed can often be treated economically with the latter materials. (See Chapter VI.)

The hardening process should be gradual as no checks are desired. Transplanting should not take place until after the late spring frosts.

Huber reports the results of a test of various methods of producing early cauliflower plants. Results indicate that the plants grown in veneer bands gave the largest number of first grade cauliflower heads and the spotted plants next. "Spotted" plants gave a larger percentage of firsts and seconds in earlier crops than the pulled plants. A comparison was made also of cauli-

flower plants some of which had been grown without a check and some of which were stunted through lack of moisture. The results show that the stunted plants seemed to make a satisfactory growth in the field but did not equal the others in yield. Good soil and careful watering must be provided at all times.

Growing Plants for the Main Crop

The production of plants for transplanting is a most important feature of cauliflower growing. Plants that are strong, stocky, and well rooted lend a valuable impetus to the proper start of the crop. They must grow steadily without check from the time of seed germination onward. Cauliflower plants are more susceptible to abuse than cabbage and broccoli plants for if they are checked in their growth they have a tendency later on to produce small "button" heads.

Location and Soil—The plant bed should be carefully selected for at least two things, first, soil that is moderately fertile, easily pulverized, and capable of holding moisture; second, nearness to field to be used.

A suitable type of soil for plant growing is one of a sandy or silt loam nature that can be worked to a fine texture so that it will be even and smooth for the seed drill. Heavy soils often pack too tightly for best seed germination, especially after heavy rains, while the lighter soils, having a porous texture, lose their moisture content unless they can be irrigated.

In some areas of the country, as in California where irrigation is necessary and considerable cauliflower is grown, seed beds must first be prepared by leveling the land and laying narrow beds for convenience in working them and in pulling plants. The soil is then well stored with water by preliminary irrigation and as many weeds as possible are killed by working the land before seeding time. Frequent irrigations will start the growth of weeds which are killed in wholesale quantities before the cauliflower seed is planted.

The desire of the grower is to produce a good, vigorous plant but one that is not too succulent or soft. As a general rule, therefore, the soil should be moderately fertile but not excessively so. Plants grown on heavily fertilized soil tend to make a soft, leafy growth which often receives an adverse reaction when set out on land that is less fertile.

The fertilization of land for seed beds, therefore, is an important consideration. The use of manure has a tendency to cause weeds in the beds and usually a softer type of plant that may not stand up well under transplanting. Manure is therefore generally considered inadvisable and unnecessary. A fertile soil in its natural condition usually grows a good plant without the addition of any fertilizer. Some growers broadcast a commercial fertilizer analyzing 6-8-5, using this at the rate of 1000 to 2000 pounds per acre and working it into the ground with a harrow previous to drilling the seed.

Having the plant beds reasonably near the field to be set will forego long hauling of plants, thereby keeping them fresher and less wilted. Seed beds may therefore be in some part of the field adjacent to the area that is later to be used for growing the crop.

Seeding should be done from five and one-half to seven weeks before the desired time of transplanting to the field or garden. In the majority of northern cauliflower growing districts seeding takes place during May and early June depending on the time desired for transplanting plants and harvesting the crop. Plants for maturity in August and September usually are started in hotbeds in April. In New York State late seed beds are commonly drilled about the third week in May. Seedings in California districts may last from the middle of May up to the latter part of July, depending on the variety used. Oregon growers seed during the first week of June or so.

Practically all growers of cauliflower make two and sometimes three seedings, commonly at intervals of seven to ten days apart. The values of this practice are: first, provision for additional plants in case of low germination of seed, or loss through insect attacks; second, successive supplies of plants and transplanting to the field are made so that the harvesting may be continued through as long a season as possible consistent with favorable weather and market conditions.

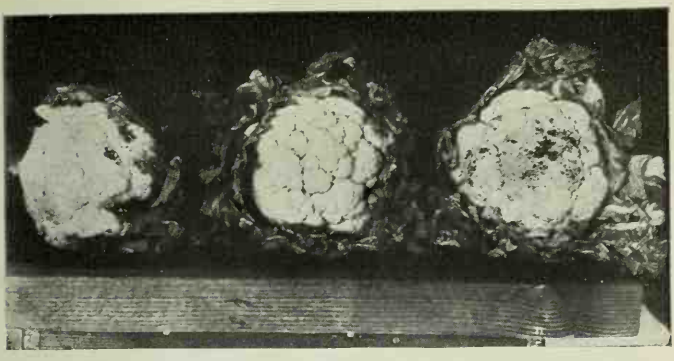
Those who do not make seedings at intervals vary their program by growing more than one

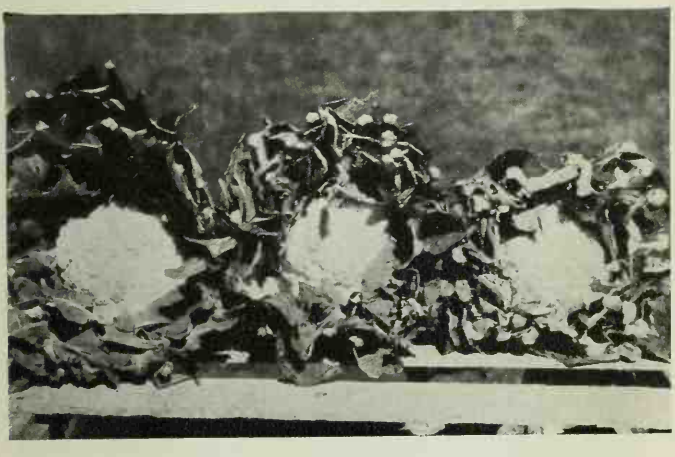
strain of cauliflower in which case one variety is known to be earlier or later than the other.

One pound of seed will commonly produce sufficient plants for about five to seven acres of cauliflower. This indicates that two to two and one-half ounces is sufficient seed for 1 acre. In view of the various factors affecting successful and high seed germination, however, many growers prefer to figure on three ounces per acre. Weather conditions, age of seed, depth of planting, ability to irrigate the beds or not—all affect the percentage of seed germination. A surplus of plants rather than a deficiency naturally would be preferred.

California growers report 12 to 15 pounds of seed as sufficient to sow an acre of seed bed and state that from this acre of plants 20 to 25 acres may be field planted. On a smaller scale one ounce of seed will plant 200 to 300 feet of drill, approximately 3500 to 4000 square feet of area being required to produce plants from a drilling of one pound of seed.

The seed is put in the ground with a hand drill at a depth of one-half to three-fourths inch, the aim being to plant from 20 to 30 seeds to the foot. A sufficient amount of soil to cover the seed is all that is necessary to provide for satisfactory germination. Deeper planting may give unsatisfactory results. There should be ample room between the rows for cultivation and general care and for removal of plants to the field. Rows should not be spaced closer than 12 to 14 inches.





V. Good and Poor Heads for Packing.

Above—Left, head over mature and blemished; center, over mature; right, blemishes spoil otherwise good head.

Below—Three grades of heads, left, ricey; middle, slightly over-mature; right, excellent.

VI. Cauliflower Packing and Inspection.

Above—Typical pack of western pony crate—widely used container holding average of 10-12 heads. See Chapter VII.

Below—Federal inspector examining stock at shipping point

Care of Plants in Beds—The plant beds should be cultivated with three objects in view: first, to maintain moisture for a steady growth of the plants; second, to keep down weeds; third, to prevent soil crusting after rain or irrigation.

If necessary, provision for an artificial supply of soil moisture may be made by locating the beds where they can be irrigated. Irrigation can be provided in either of two ways: by means of the overhead sprinkling system or by irrigation in furrows. Irrigation should be given often enough to promote a healthy, continuous growth, but toward the end of the seed bed period the plants should be deprived of water for a few days so they will be hardened off for setting in the field. Experience has demonstrated that plants in a tender, fast growing condition are more seriously shocked in transplanting than those which have been prepared for the ordeal without necessarily being checked in growth to any appreciable extent. Plants are rarely thinned in the beds unless there is considerable overcrowding.

Control of Pests in the Plant Beds—There are five important insects which may do more or less damage to young cauliflower plants, including wireworms, cutworms, maggots, lice, and green worms.

While the control of these is discussed in the chapter on "Pest Control" a few additional remarks herewith may prove of value.

Two dependable methods for protection of the seed beds from the maggot include (1) the cheese-

cloth screen and (2) treatment with corrosive sublimate. Cheesecloth having 20 to 30 threads to the inch is tacked on a framework of boards forming a supporting wall about the bed, and this is put into place following seeding.

Three applications of corrosive sublimate are recommended, the first to be made as soon as the plants are well through the ground followed by two later applications at intervals of a week or 10 days. One gallon of the material will treat 30 to 40 feet of row. Cutworms can be controlled by the usual arsenical bait as stated in Chapter VI.

Aphis and green worms are prevented from doing injury by the use of a complete dust composed of lead arsenate, nicotine, and lime or sulfur as a filler.

Wireworm control is treated in Chapter VI.

Direct Seeding in the Field

A somewhat uncommon but effective method of growing cauliflower is to sow the seed directly in the field where the crop is to stand, thus eliminating transplanting of plants except in a minor degree where it becomes necessary to fill up spaces in the rows.

The values of this method may include (1) little danger of check in growth provided favorable conditions are present; (2) work of transplanting obviated; (3) possibility of uniform stand of plants.

The disadvantages of the method are that (1) the seed item is more costly; (2) the ground

cannot be used so long for a previous crop in a rotation; (3) lack of transplanting is more or less offset by the work of thinning and some transferring of plants; (4) soil must be of good tilth and moisture to produce an even stand of plants.

The seed is sown directly either in hills or drills, the latter being preferable in which case about three-fourth of a pound of seed is used per acre in drills 36 inches or so apart. Thin plants when about five inches high to stand at the usual growing distance of 24 to 30 inches apart.

Transplanting Plants Into the Field

Seasons of setting out plants for the main cauliflower crop are determined by: first, the location of the grower producing the crop; second, the time desired for maturity, and, third, time of sowing the seed. In Central California fall cauliflower plants are set out in the field during August and September; in Southern California the transplanting is all finished by at least a month later. In New York State this operation occurs during the last two or three weeks of July; in Oregon during late July; in Colorado May 15 to June 10. The work may extend therefore over several weeks and the actual time may further be determined by any previous cropping of the ground before the cauliflower plants are set as well as by prevailing weather conditions. Cloudy or rainy weather should always be taken advantage of for this operation.

Plant Digging, Selection, and Preparation—Plants of good size and stocky type are desired for field setting. It pays to select and grade these carefully in order to secure a better and more even stand in the field. The best size of plants is from 8 to 10 inches in height with a well branched root system.

The beds should be thoroughly wetted several hours previous to lifting the plants, so that moist soil will adhere to the roots. The plants can be pulled or dug with a fork or spade, depending on the type of soil in which they are growing. They are then sorted for uniform size, some of the larger leaves are removed, if necessary, and the plants are put into boxes, lined with wet sacks to keep them fresh and unwilted. If the plants are not transplanted for several hours or even a day or so following digging, they should be "heeled in" by covering the roots with moist soil. Fine white feeding roots will form during this period which will help the plants become more quickly established when transplanted.

Mudding—This operation, sometimes known as "puddling," consists in dipping the roots in thick clay muddy water. If the soil in the field can be well supplied with moisture or can be irrigated, and the weather is cloudy or rainy, mudding will be unnecessary; otherwise it is helpful in causing the soil particles to stick to the moist roots, thus inducing root formation.

Leaf Trimming may or may not be necessary, according to soil and weather conditions. If con-

tinued hot weather prevails during the setting season, the removal of some leaves is advisable, especially if no irrigation follows plant setting.

Plants sometimes may be affected with lice, root maggots, or green cabbage worms, in which case the tops can be immersed in a solution of Black Leaf 40, so that they will be free from any insects as they go into the field. For further notes in regard to pest control, observe the suggestions given in Chapter VI.

Plant Setting—There are three methods of transplanting plants; first, by horse drawn or motor machine; second, by hand planter; third, by means of a spade, trowel, or similar tools.

The transplanter machine is widely used in areas of considerable acreage. Approximately four acres can be set each day and water is applied to each plant as the machine operates. Plate III shows such machinery operating in setting cauliflower plants. Machine planters operate rapidly and can be used advantageously in setting plants in dry weather. Careful machine planters see that the plants are equally spaced. Production costs are reduced by reason of the rapidity of setting plants. Whereas cultivation was possible in only one direction when these machines were formerly used, two-way cultivation can now be accomplished by using either a check row attachment or foot trap attachment.

Hand planters are used by some growers, in which case the plants are set at the intersections of a field previously marked out. Distances of

setting plants are usually 3 feet between the rows and 24-30 inches between the plants, thus necessitating between 5800 to 7200 plants per acre.

Hand planting is particularly common with those who have small areas to transplant, although in some exceptional cases large fields are set by hand. After the soil has been put in fine physical condition and the rows marked out, two individuals can cover from one-half to three-fourths of an acre per day. The hole is quickly opened by one digger with a spade, the plant put in by the second operator and the digger firms the plants by stepping on the soil about the plant. In some cases a tile spade is a good tool with which to make the hole for the plants, being especially useful for all plants to get them down more deeply than stockier ones.

California planters set large areas by hand by placing the plants on the side or bottom of a furrow depending on soil types and covering the roots by means of a short handled hoe.

Carefulness in setting plants at even distances in the row is very important. Uniformity of growth is materially affected by equal distances between plants in the rows. It is far preferable to spend a longer time to do a careful job of transplanting than to rush the work to cover a greater area per day. The importance of the work rightly done cannot be over-estimated. Especially is this true when transplanting must be done in hot weather. Setting plants in the cool part of the day is generally preferable.

VI

INSECTS AND DISEASES

Insects

Insect pests common to many of the brassica family attack cauliflower and in some cases make decided inroads on the crop.

Cruciferous weeds may serve as centers of infestation from which insects spread to cultivated crops. This is notably true with cauliflower aphis.

In the case of the maggot there seems to be a decided preference for it to attack cauliflower plants in contrast to possible nearby plantings of cabbage.

Some of the insects injurious to cauliflower are listed among the group of general pests including cutworms, wireworms, and slugs.

The Root Maggot (*Hyleymia brassicae*)—While this insect is commonly called the cabbage root maggot, it is equally injurious to cauliflower. Of all insect pests attacking cauliflower it is possibly the most serious and the most difficult with which to contend because it works underneath the ground, burrowing into the roots and stalks. Injury is oftentimes unnoticed by the gardener until the roots are badly infested, the plant is wilting and about ready to succumb, or beyond any means of help.

The parent two-winged flies, not unlike the common housefly, appear early in the spring and deposit eggs

at the base of the stem usually between the soil and the stem. The eggs hatch in four to ten days and the young maggots, waxy white or yellowish in color, burrow at once into the stem or roots of the tender plant. The maggots reach maturity in from a month to six weeks, pupate, and emerge again as adult flies.

Plants attacked by maggots have typical symptoms of stunted growth and a sickly yellowish color of the leaves which wilt readily in warm days.

Of a great variety of control measures recommended and practiced corrosive sublimate or bichloride of mercury is most widely used. This material is first applied in the seed beds where infestation during May and June may be most likely to occur. Methods of control of the maggot in the seed bed have already been described in Chapter V.

For early cauliflower plants set out during the egg laying period infection may be avoided by the use of commercially made tarred paper pads fitted around the plants just after they are set out. The pads are not covered with soil, but set smoothly on the soil surface and they must fit snugly to keep out the flies and maggots.

If corrosive sublimate must be used in the field after plant setting, application should be made three days after transplanting with successive treatments a ten day intervals. A barrel in the rear of a wagon with two reels of hose and stop cocks affords means of applying two liquid ounces to the plant, poured on the surface soil about the plant. Four 50 gallon barrels of the corrosive sublimate per acre would be necessary for each application. On a small scale in the home garden one-half of a cupful would be used, poured directly on the soil right against the stem.

The corrosive sublimate controls by killing the eggs

as well as the small young maggots before they have entered the roots. Growers are advised, however, to use the corrosive sublimate as a preventive of maggot infection rather than as a control measure.

Tobacco dust is effective in controlling the maggot in the plant beds, best results being secured when the material is applied at the rate of 1 pound to from 30 to 40 feet of row. This treatment is more expensive than the corrosive sublimate method.

The Imported Cabbage Worm (*Pontia rapae*)—This insect feeds on the leaves of cauliflower and besides consuming the foliage of the plant often does serious damage by excreting on the white heads and causing them to lose their marketable value. The velvety green worms are the progeny of the well known white butterflies that are familiar about the garden. There may be at least three generations during the season, the injury to the cauliflower being mostly during late summer and fall. Plants in the seed beds are often chewed by the worms.

As a general rule control is not difficult inasmuch as either arsenical sprays or dusts will reduce the injury to a minimum degree. The dust is usually superior for small areas, and if first applied when the plants are small and repeated two or three times will keep them well protected. Nicotine sulphate mixed with arsenate of lead forms an added control measure for aphis as well as the worms. Dusting or spraying must be completed before formation of the small white cauliflower heads.

The Diamond-back Moth (*Plutella maculipennis*)—This insect in the larval stage is quite small, measuring when mature about three-tenths of an inch. It is of a pale green color, very active, and easily disturbed. The leaves are eaten from the under side

of the cauliflower plant which is attacked. The adult moth is named from its diamond shaped markings of united yellow stripes when the wings are closed.

This worm can be controlled by spraying the underside of the leaves with an arsenical mixture to which soap has been added. Two pounds of lead arsenate to six pounds of soap and 50 gallons of water can be used as a control measure.

Aphis (*Aphis brassicae*)—The cabbage aphis is likewise a serious pest on cauliflower. Usually collecting in large numbers they cause the leaves to curl, often stunting the plants severely enough to be useless. Plants lacking vigor seem to be particularly affected. Lice may sometimes cause more injury than a prolonged drought. The young tender center leaves of the plant are especially subject to attack as well as the upper and lower sides of the larger outside leaves. Plants may be infested with lice in the seed beds, as previously mentioned. For successful and economical control early dusting or spraying is necessary.

Commercial nicotine dusts used as a preventive to check infestation are most valuable, thus preventing sufficient numbers of lice to be present to cause leaf curling. Curled leaves make delayed dusting or spraying difficult, and oftentimes inefficient. Actual contact of the control measure with the lice must be obtained. Lady bird beetles are efficient enemies and destroyers of aphis.

A driving Black-leaf soap spray applied when the lice first appear is effective. Two or more repeated applications may be necessary through the season.

Jones and Ernst recommend 30 pounds of dust per acre, of the formula 95 pounds hydrated lime and 5 pounds of 40 percent nicotine sulphate. If larger

plants are to be dusted 50 pounds per acre would be necessary. Dipping the plants before setting them in the field has already been discussed under the heading of plant growing.

The Cabbage Looper (*Autographa brassicae*)— So-named because of its looping motion. The pale green larvae hatch from eggs laid by a moth resembling the cutworm moth. When larger, the worms become darker green and have white longitudinal stripes. They are smaller and more active than the imported cabbage worm.

An arsenical spray with adhesive sticker is the best remedy, using 2 pounds of lead arsenate mixed with 50 gallons of water to which the calcium caseinate mixture is added.

Cutworms (*Noctuidae sp.*)— These well known caterpillars of varying shades of gray, brown, and 1-2 inch in size when mature, often do extensive injury in cauliflower seed beds as well as in the field. Small and even large plants are cut off at the surface of the ground. The heart of the plants in the field may be entirely eaten out.

Poisoned bran mash is a quick and sure controlling measure, scattering the poison lengthwise of the rows in the seed bed and making an application of a spoonful to each plant in the field. If numerous, a preventive treatment of broadcasting the field before planting will give excellent results. Home gardeners can advantageously use cylinders of cardboard pressed into the soil about the plants and allowed to project about 2 inches above the ground.

Wireworms (*Elateridae sp.*) occur in the soil as elongated, hard-shelled brownish larvae varying from one-half inch to an inch long. Considerable injury has been reported from various cauliflower growing sections. The plants in the seed beds may be at-

tacked as well as those later transplanted to the field. Plate IV illustrates typical seed bed and field injury which consists of roots eaten and stems bored into by the worms.

Control measures consist in practicing a short rotation of crops and in baiting. Poisoned baits include rice bran balls, poisoned bunches of clover, and poisoned corn meal dough. These baits are distributed before the ground is planted. Carbon bisulphite is also used with success.

Grains of field corn are attractive to wireworms. The corn seed should be drilled in thickly in rows 3 feet apart across a field, and it will attract the wireworms from the spaces between the rows in about two weeks. Calcium cyanide is then applied to spots where the wireworms are found, using 10 ounces to 100 lineal feet of baited row. In a week after application, regular crop plantings can be made. Spring is the best time for treatment as the worms are active near the surface in early spring. The soil should be well pulverized and the cyanide applied during fair weather.

Slugs (*Limax sp.*)—The leaves as well as the head of cauliflower plants may be severely injured by this slimy, slow-moving, gray ~~insect~~ mollusk. During the cool, wet days of the fall the white heads are particularly susceptible to damage, often being punctured and gnawed to such an extent as to destroy their marketable value.

Commercial dry bordeaux may be used as a dust but in the heading stages the plants are better protected by using the poison bait mentioned under "Insecticides." The poisoned bran mash recommended for cutworms is of nearly equal value. The essential factor is that the poison be calcium arsenate. Lead

arsenate or the other poisons will not give an equal degree of efficiency.

Diseases

Black Rot (*Pseudomonas campestris*) is a serious disease of cauliflower being reported by Clayton. Bacteria cause large wilted areas to appear, the midrib later being affected, followed by rotten cavities extending some inches down the leaf to the stem of the plant. The lower leaves are later attacked and soft rot afterwards gets inside the diseased stems and the plants soon succumb.

Corrosive sublimate as applied for the root maggot has given excellent control of black rot. Some late set plants seem to avoid the disease.

Whiptail—This is considered a malnutrition disease causing light colored and narrowed ruffled leaves. The plants are later dwarfed with head development varying from none at all to ricey, leafy culls. Some fields may show as much as 90 percent infection. Strains of the same variety of cauliflower seem to vary in susceptibility.

Heavy applications of commercial fertilizer induce whiptail, but applications of lime up to 3600 pounds per acre seem to effectively control the trouble. The disease is reported to be induced by treating the soil with sulphur and sometimes occurs when the plants are severely attacked by aphis.

Club Root (*Plasmodiophora brassicae*) is a well known disease of the brassicas causing swollen and distorted roots. Control has been effectively obtained by liming the seed bed 3 to 12 months in advance of planting. Chupp recommends two to three tons per acre worked into the soil. The use of corrosive

sublimate treatment as for maggots is also effective in the seed bed.

Ring Spot (*Mycosphaerella brassicicola*) causes dark purple spots up to an inch or more on the leaves. Control as for black leg is recommended, as well as low humidity and temperature slightly above 32 degrees F. to prevent damage by the disease to cauliflower in transit.

Black Leg (*Phoma lingam*)—This disease blackens and kills the stem of young plants in the seed bed or any time later in the summer. Dark, sunken, irregular black areas occur near the surface of the ground.

Corrosive sublimate treatment of the seed bed will greatly reduce the amount of disease. This treatment is therefore useful for control of maggots as well as black leg.

Damping-off (*Various fungi*)—Seedlings are attacked at the surface of the soil, the stem is girdled, and the outer tissue is destroyed. The plant later falls over and dies. The disease may be prevalent in open seed beds although it is more common on early plants grown under glass.

Soil disinfection by means of solutions of corrosive sublimate or commercial organic mercury compounds is recommended according to the suggestions under "Insecticides and Fungicides."

Peppery Leaf-spot (*Pseudomonas maculicolum*)—This is the common leaf-spot of the cauliflower plant bed in the early summer, attacking also spring grown cauliflower in the field and sometimes again in the late fall.

Control has been satisfactorily obtained by planting hot water treated seed in sterilized soil.

Alternaria Leaf-spot (*Alternaria brassicae*)—

Brown leaf-spots are scattered over the lower leaves as symptoms of the disease. Chupp mentions the injury to cauliflower as described by Vogel as a browning of the head and this discoloration may finally cover a part or all of the head. Little can be done to eliminate spotting of cauliflower.

Formulas and Directions for Insecticides and Fungicides

Corrosive Sublimate—

Corrosive sublimate (mercuric chloride) . . 1 ounce
Water . . . . . 10-12 gallons

Dissolve the corrosive sublimate by mixing it first with a stick in a little warm water in a glass, wooden, or earthenware vessel, later diluting to 10-12 gallons. It requires about ½ gallon of water to dissolve an ounce readily.

Apply two liquid ounces to each plant in the field, so that the soil is soaked around the stem. The plant beds should be well soaked.

Arsenate of Lead (dust)—

Arsenate of lead or calcium arsenate (by weight) . . . . . 1 part
Sifted wood ashes, air slaked lime or sulfur (by weight) . . . . . 4-6 parts

Mix materials thoroughly. Apply lightly in still air. Commercial arsenate dust may be bought ready to use.

Arsenate of Lead (spray)—

Arsenate of lead (powdered) 2 pounds or 2/3-1 ounce
Calcium caseinate . . . . 6 pounds or 1/2-1 ounce
Water . . . . . 50 gallons or 1 gallon

In preparing the mixture the arsenate should be made into a thin paste with a small quantity of water and then diluted to desired strength. The calcium caseinate should be handled likewise.

Nicotine Dust—Commercial nicotine dust can be purchased already prepared for use or may be made up by the gardener as follows:

Put 50 pounds of hydrated lime in a 50 gallon barrel. Pour on top of the lime the desired amount of Black Leaf 40, approximately 2½ pounds for 2 percent actual nicotine or 1¼ pounds for 1 percent actual nicotine. For each pound of dust, use one-half pound of pebbles, from ¾ inch to 1½ inches, in the mixer. Rotate to speed of 35 revolutions per minute for 5 minutes. Screen and store in tight metal drums.

Nicotine Spray—

Black Leaf 40	¾-1 pint
Soap or calcium caseinate	4-5 gallons
Water	100 gallons

Useful for plant dip solution before transplanting. Dip the infested portion of the plants, either root or top. Do not submerge the plants.

Poisoned Bran Mash—

Coarse bran	25 pounds
Paris Green or white arsenic	1 pound
Salt	¼ pound
Molasses	1 pint

Use water to make a coarse crumbly mash. The white arsenic and dry bran are first mixed in a container. In another vessel stir a pint of cheap molasses or sirup in 3 or 4 quarts of water, then slowly add the mixture of molasses and water to the poisoned

bran. The bran should not be sloppy but fall apart readily in the hand after being pressed together. Broadcast over infested area at rate of 12-15 pounds per acre.

Tarred Pads for Maggots—A. B. Cowles Co., Rochester, N. Y.

Poisoned Bait (for slugs)—

Calcium arsenate .....1 ounce
Chopped up lettuce leaves .....1 pound

Mix well and scatter in small heaps about the soil around the plants to be protected. In case lettuce is not available, use tender foliage of cabbage, kale, clover, or other succulent leaves.

Calcium Cyanide (for wireworms)—Apply directly down the baited rows placing the material an inch or two deeper than the bait and directly beneath it. 10 ounces to 100 lineal feet of baited row is recommended.

Mercuric Compounds, "Semesan," "Uspulun," etc.—

1. For seed disinfection (dry) use ½-1 ounce to 15 pounds of seed. Shake thoroughly together for 5 to 10 minutes.

2. For seed disinfection (soaked) used 2 oz. to 6 gallons. Seed should be dipped in bag in solution for ½ hour. For sowing with a drill it is necessary to spread the seed out to dry before planting.

3. For seed bed disinfection in greenhouse, hotbed, or field, previous to seeding, use similar solution as for 2.

4. For plant bed treatment to stop progress of "damping-off" use 0.25% solution or approximately 1 pound to a 50 gallon barrel. When disease first ap-

pears sprinkle or pour this solution into the soil putting on sufficient to penetrate soil at least 2 or 3 inches. Repeat if necessary at intervals of one to two weeks.

5. For disinfecting soil after sowing seed use the above solution instead of plain water.

VII

PREPARATION FOR MARKET

Blanching—A perfect type of cauliflower head is naturally white. Some heads are normally yellowish, pinkish, or purple and can never be made white. These are from deteriorated types or strains of cauliflower. The market specifically demands a snow white color which characteristic is fully as important as proper maturity and size. Various factors may spoil this desirable white color. Sun, rain, frost, light, soil particles, insects, fungi—all contribute toward discoloration and blemishing of the curd.

Certain varieties of cauliflower have the heads protected by the so-called jacket leaves surrounding and curling over the head, such types being called "self-protecting." (See Chapter on "Varieties.") It is not uncommon to find strains of cauliflower in which the jacket leaves so closely fold over the head as to naturally protect it and keep it white even up to the stage where the head is large enough to be cut. As a rule, however, while the jacket leaves at first may afford protection to the head when small, later on, as the curd enlarges, it pushes through the jacket leaves and is partly exposed and subject to discoloration unless covered.

There is, therefore, a general practice of tying the outer leaves over the heads in which case they

are drawn up together and tied with twine or raffia. Sixteen-inch length pieces of jute are used in New Jersey. Oregon growers use 20-inch lengths of binder twine. Raffia is also used as well as rye straw. Some growers use different colored twine in tying on different days which aids in harvesting. In some cases the leaves are folded over and fastened with a skewer.

Leaves should be tied when the heads are the right size. Growers report that if they are tied too early the heads will not develop nor grow as large as those whose leaves were tied at the right time. A general rule is: tie the plant when the leaves covering the flower show signs of breaking away and begin to expose the small curd to view when looking downward on the plant. The size of the plant will largely determine the size of the head before it is tied. From two to four inches will represent the average diameter. DeBaun refers to the importance of this work, recommending that if the leaves are tied too early the plant may be stunted. One man can cover 800 plants per day at average speed.

The time elapsing between tying the leaves and cutting the heads will be almost wholly determined by prevailing weather conditions. In good warm weather harvesting may occur from 2-5 days after tying. During the cool days of the fall the time may be considerably longer, even up to 14 days. Heads tied the same day will usually be ready to harvest at the same time.

A careful inspection of the field at regular in-

tervals is necessary to be sure that harvesting will be done when heads are in "prime condition."

Harvesting

Maturity—It is very important that cauliflower heads be cut at the right stage of maturity or development of the curd. The solid head with its white color must be preserved in order that the product may arrive on the market in the best possible condition.

As applied to the harvesting of the crop the terms concerning maturity of the head may be stated as follows: (1) immature—not yet fully developed in growth for havesting; (2) mature or prime condition—head has reached large enough size for cutting, is compact, showing no signs of spreading, color white; (3) over-mature —head has begun to separate, or spread, showing segments of the curd. (Plate VII.)

When small and immature the curd is quite compact and shows no signs of segmentation, continuing to show no spreading as it enlarges until the first stages of over-maturity.

In harvesting, therefore, there should be no signs of segmentation or spreading of the curd when cauliflower is cut in the field. Jones and Ernst recommend the policy of disregarding the size feature of the time of harvesting and considering only the stage of maturity. This is sound advice. There is probably a tendency for cauliflower growers to err more in this feature of harvesting than in any other. It is uncommon

to find growers who cut heads that are immature or too small. The tendency is rather toward leaving the heads too long in the field before cutting with the result that prime condition is often sacrificed for size. Small to medium sized heads that are compact and white are much more desirable than large heads lacking white color or compactness. Small plants in the field rarely, if ever, bear large heads, no matter how long they are left uncut.

A slight separation or spreading of the curd in the field will be even more pronounced at destination. A study of the shrinkage of cauliflower heads in relation to various degrees of maturity when harvested was reviewed by the writer with the following results:

TABLE IV.—SHRINKAGE OF CAULIFLOWER HEADS ACCORDING TO VARIOUS DEGREES OF MATURITY WHEN HARVESTED

LOT NO.	*Prime Condition* percent	*Slightly Over-mature* percent	*Over-Mature* percent	*Length of test* days
1	15.8	22.8	25.5	11
2	10.5	17.5	23.0	12
3	14.0	22.0	31.0	17

The average loss in weight of the heads harvested in prime condition was approximately 8-9 ounces per head; 13 to 13.5 ounces of those slightly over-mature, and 16.9 ounces of those over-mature. Figuring an average of 10 heads per crate for the entire carload the loss per crate of the various degrees of maturity would be respectively 5 pounds 5 ounces; 8 pounds 2

ounces, and 10 pounds 9 ounces. There is, therefore, danger of increasing the shrinkage of a crate just twice the normal amount by allowing the heads to remain uncut in the field. Added to this, also, is the fact that the appearance of heads harvested when over-mature lessens their chances of a sale at any profitable price.

By closer observation of the development of heads in the field a larger percentage can be marketed in "prime condition" thus insuring satisfaction to both grower and buyer and the greatest profit.

In harvesting the crop each plant is severed with a sharp knife well down toward the ground, the aim of the cutter being to have sufficient leaves attached to the head to form ample protection in the crate. Hauling from the rows to the place of packing varies in different production areas. High wheeled carts that straddle the rows are used, in which case the heads are loaded in bulk and later taken to the packing house. Sleds are also employed for hauling to the packing house, to the end or sides of the rows, or to a place in the field if individual packing on the farm is to be done. Conveyors about four feet wide move the heads slowly to the packers standing on either side. Inspection at the end of the conveyor permits the elimination of undesirable stock.

Marketing Containers

Packages for marketing cauliflower vary considerably according to the section of the country

where the crop is grown. Western growers in general, however, have standardized the use of the so-called "pony" crate. Considerable evolution of marketing containers for shipment has taken place within the past 10 years. Large crates, such as the western double tier crate and the eastern barrel, have largely given way to smaller crates of one tier. Growers have realized the perishability of the crop and the readiness with which heads may become bruised and blemished. Large crates are sometimes used for local marketing or short distance shipping.

The characters desired in a suitable container for marketing cauliflower include (1) proper protection of the vegetable, (2) easy inspection, (3) sufficiently good cooperage of the package, (4) easy handling of the commodity, (5) cleanliness. Any container should be such as to keep the heads free from injury, bruises, or dirt. With a proper amount of jacket leaves surrounding the head it should be sufficiently protected. Much cauliflower is now inspected, and containers such as the one-tier crates make possible easier inspection. The proper construction of the crate is most important. Instances have been known in which many crates collapsed during handling at destination on account of being carelessly and insufficiently nailed. Nails should be clinched and not protrude from the crate. Clean crates are necessary for a good appearance of the packed product. First impressions of buyers are ex-

tremely important. Any crates that are weather beaten or discolored should not be accepted.

Different kinds of packages are confusing to buyers and a national uniformity of crates in the United States is desired. The most satisfactory carrier for this purpose would appear to be the one-tier crate such as the Western pony crate or the Erie County crate.

TABLE V.—CONTAINERS FOR MARKETING CAULIFLOWER

STATE	*Kind of Containers*	*Dimensions (inches)*	*Capacity (heads)*
California	Pony crate	8¼x18 x24½	8-15
	Standard crate	13 x18 x21⅞	20-30
Colorado	Pony crate as above		
New York	Long Island crate	13 x15¼x23 (outside)	12
	Erie Co. crate	8 x18 x24¼ (inside)	11
	Catskill Mt. crate	14 x18 x26	12-15
Oregon	Pony crate as above		
Louisiana	Pony crate as above		

GRADES AND GRADING

Sorting and sizing cauliflower heads after cutting is an operation necessary for the establishment of definite standards and grades by means of which grower and shipper can have a mutual understanding as to the character of the product. In all large shipping districts growers realize the necessity for definite practical grades closely observed. The permanent success of the cauliflower industry of any section depends on sending to the market a product rigidly graded and highly standardized.

The segregation of heads as carried on in the

packing house or field is based on the following characters: (1) maturity, (2) color, (3) size, (4) condition and formation of the curd, (5) miscellaneous.

Maturity has already been treated in previous paragraphs. The curd must be compact, solid, unsegmented. Spread heads, if fresh and clean, may often be used for pickles.

There should be no question as to the unblemished, white color of the curd. Any doubts in this connection in the way of spots and discoloration, partial yellowing or blemishes, should automatically throw the heads into an inferior grade.

There seems to be a definite preference in the larger markets of the United States for cauliflower of medium size. Either extreme of size is objectionable. In the Pacific coast sections this means that a size packing 10 to 12 heads per crate is most desired. Such heads average 5 to 6 inches in diameter.

The formation and appearance of the heads are important. These characters may be divided as follows: (1) evenly formed, (2) rough, (3) ricey, (4) leafy, (5) fuzzy, (6) blemished, (7) discolored.

Evenly formed heads result from the combination of flower stems or floral branchlets of even length, so that the curd is regular in shape and outline, an essential character for Grade No. 1.

Rough heads are uneven in appearance due to irregular lengths of the segments. The roughness may be caused by leaving the heads too long

uncut in the field, or in some cases the heads are naturally rough even in an immature and prime condition.

Ricey heads have the granular appearance of a mass of rice grains in which the individual parts of each segment show, instead of the head having a solid homogeneous formation as in the smooth heads. Ricey heads are undesirable for market even though the quality is unimpaired. Rough heads need not necessarily be ricey, but ricey heads are commonly uneven due to low quality seed, unfavorable weather conditions, and over-maturity. A sudden growth, following a check or standstill of the plants, stimulates the development of the flower branches, and commonly causes riciness.

Some heads have a fuzzy, velvety appearance due to the stems of the flower buds beginning to elongate. The conditions that cause riciness are also responsible for fuzziness.

Leafy heads are commonly found in fields where poor seed has been used. Small green leaves show between the segments of the curd and the heads of this type are not desirable for marketing except as lower grades.

United States Department of Agriculture suggested grades are as follows:

U. S. No. 1 grade shall consist of compact heads of cauliflower which are not discolored, ricey, fuzzy, or over-mature; which are free from damage caused by enlarged bracts, dirt or other foreign matter, bruises, disease, insects, mechanical

or other means. Jacket leaves shall be fresh, green, and well trimmed.

U. S. No. 2 shall consist of heads of cauliflower which are free from serious damage caused by over-maturity, discoloration, dirt or other foreign matter, bruises, diseases, insects, or mechanical or other means.

In addition to the above recommendations western growers using the pony crate observe the following:

Unless otherwise specified the minimum size for grade No. 1 shall be 3½ inches in diameter.

Count shall be not less than 9 or more than 14 heads per crate.

Any crate containing a sliced head shall be thrown out.

Heads showing beginning stages of over-maturity or spreading shall go into grade No. 2 even though white.

Pack showing wilt will not be accepted.

Packing

In the one tier crate, such as is used on the Pacific coast, the heads are packed butts downward at as even a height as possible, the apex of the head being preferably from one and one-half to two inches from the top of the crate. The empty crates are set on an angle on the packing tables and are packed by experts. Important points of good packing include:

1. Uniform sizing or packing of uniform sizes.
2. Apex of heads at uniform height in the container.

3. Tight pack.

4. Correct proportion of jacket leaves about the head.

5. Carefulness in handling.

Crates having a uniform size of heads are most desirable. A crate holding 12 heads should not contain a 6 or 8 size and one or two thirteens.

The appearance of the pack is greatly improved by the uniform height of the heads as they stand in the crate. Inspection is also difficult when some are high, some low. Every head should be far enough below the top of the crate so that the slats do not touch the flower.

A tight pack is essential so that the crate arrives at its destination without the contents being loose.

Buyers of cauliflower strenuously object to too much green foliage around the heads. There should be only a sufficient number of jacket leaves around the heads to properly protect them from injury. Eighteen to 20 leaves form ample protection.

Carefulness in packing is necessary to keep the curds free from bruises, finger marks, and dirt. The heads should be handled in such a way that only the jacket leaves are held tight as the head is put into place. Some crates are partly ruined by having a portion of the head protruding through the slats of the crate. Excelsior as well as paper coverings is considered undesirable.

Trimming of the foliage extending above the top of the crate after packing is done by shearing the leaves smoothly with a large knife. Western

packed crates have a 1½-2 inch bulge over which the three narrow slats forming the top are nailed.

A somewhat uncommon method is the entire trimming of foliage from the heads and then wrapping them in wax paper. Some markets prefer cauliflower wrapped in this manner, but only in rare instances is this a market requirement.

Federal Inspection

It is both undesirable and uneconomical to ship cauliflower and broccoli of inferior quality. Assisting in keeping such produce out of the channels of trade is the federal and federal-state inspection which is given a majority of the cars of cauliflower shipped from the main growing areas. When such cars bear the stamp of the federal inspector they carry with them a guarantee of grading and packing which have met the Federal requirements.

The confidence of buyers is established by supplying a product that is consistently well graded and packed, and an increased price is obtained where a high grade is consistently maintained.

An inspection certificate is accepted as prima-facie evidence in all federal courts of the United States. The fee for inspection is usually $5.00 for straight carloads.

Car Loading, Transportation, and Crop Movements

Efficient methods of carrying perishable vegetables to their destination are of the utmost im-

portance. In sections where cauliflower is grown widely and shipped in carload lots the rapidity with which the product, following harvesting and packing, reaches its destination largely determines its salable condition.

Refrigeration—For several years previous to the present method of icing cars cauliflower shipped by growers living a long distance from the market suffered in that the jacket leaves about the head had a tendency to turn yellow in transit. These green leaves represent one of the salable characters of the cauliflower but when yellow they tend to spoil the good appearance of the white curd; hence, the desirability of keeping the jacket green as long as possible.

Refrigeration methods, therefore, center on keeping the cauliflower turgid, compact, and unwilted, and preventing the green jacket leaves from shrinking and from becoming yellow.

During recent years improved methods of refrigerating cars have been adopted so that at the present time many western cars are not only iced in the bunkers but are also "top" or "body" iced on top of the load.

Standard refrigeration consists in filling the bunkers at either end of the car with 5,500 pounds of ice at loading point. Re-icing at intervals in transit is necessary. In case the load is "top" or "body" iced 30 to 40 pound blocks of ice are put on the top tier of the load and in the tunnels or pigeon holes, the total amount used per car varying from three to five tons. This top icing will

not have to be renewed in transit. "Tunnel" or "pigeon hole" icing is sometimes used when western pony crates are loaded alternate rather than solid, thus permitting blocks of ice to be placed between the rows of crates lengthwise of the car.

In eastern cauliflower sections cars may be iced in one of two ways, initial icing or route icing. Initial icing is done at the loading point with no further icing in transit. Route icing indicates that the car is to be re-iced at intervals to keep the car at the proper temperature.

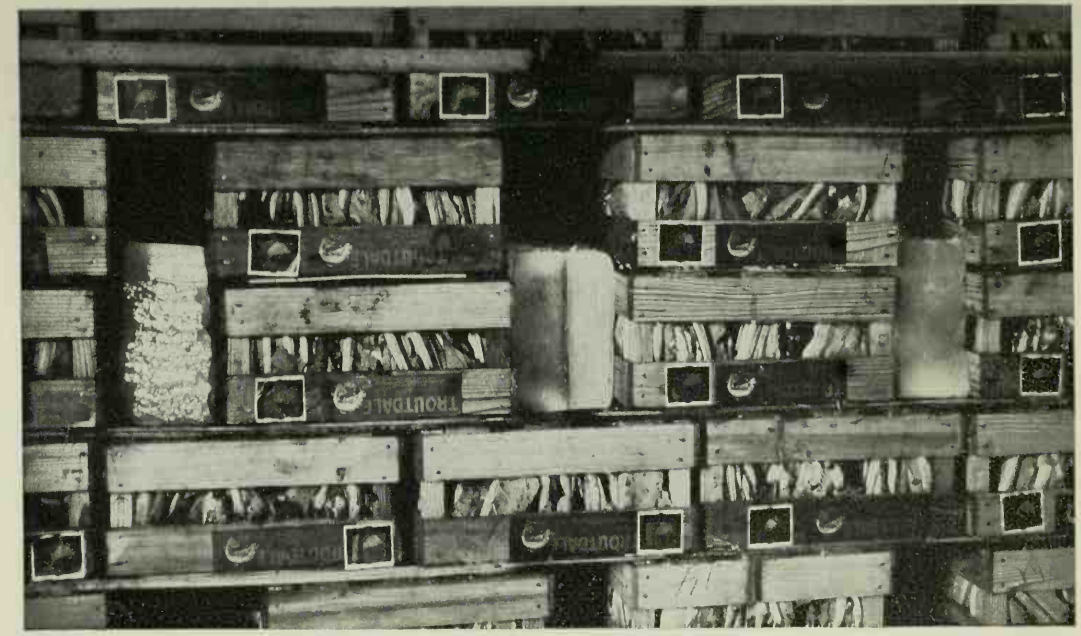
Loading of cars varies according to (1) the kind of container used, (2) distance of shipment, and (3) heaviness of load desired. One tier pony crates are commonly loaded 480 to 512 to the car. Some cars are loaded more heavily than others if shipped a shorter distance. Loading should be sufficiently heavy to make up the minimum car weight of 20,000 pounds. Top icing has made possible heavier loading than before.

The following table explains different methods of loading cars with one tier Western crates:

TABLE VI.—METHODS OF LOADING CARS OF CAULIFLOWER

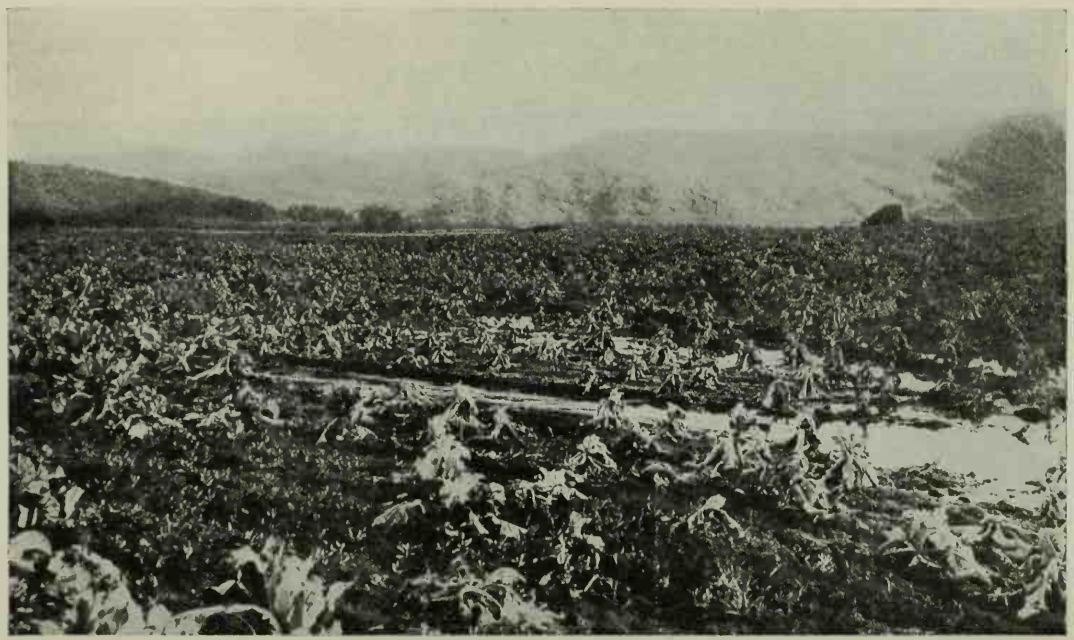
DISTRICT	*Container used*	*No. of crates in car*	*Crates Wide*	*High*	*Long*
Calif., Ore.	pony crate	512*	(4) 5	7	16
Colo., Utah ...	" "		(3) 4		
Colo., Utah ...	" "	480	5	6	16

* Load is seven layers high; four layers, namely the two bottom, fifth, and seventh layers are five rows wide; the third, fourth and sixth layers are four rows wide.



VII. Loading Cars for Shipment.

Of various methods in use, this is the alternate loading of 4 and 5 wide; ice blocks in pigeon holes as well as on top of load.



VIII. Broccoli Land Must be Well Drained.

Portion of this field (in foreground) was low and poorly drained. Investment in drain tile would have returned a high interest. Land both on left and right of view higher and well drained.

VIII

YIELDS, COSTS, AND VALUES

As is generally true with vegetable crops grown under widely varying conditions of climate, soil, and culture, the production of an area planted to cauliflower differs considerably in actual yield.

Important factors that influence yields of cauliflower fields include the following: (1) seed strain, affecting correctness and uniformity of type of plant, (2) stand of plants in the field, (3) vigor of plants, (4) amount of insect and disease injury, (5) favorable weather conditions through the growing and harvesting periods, (6) ability of grower to harvest a maximum number of heads in prime condition, (7) market conditions.

If the plants are generally of one good type, uniformly throughout the field, the number of packed crates to the acre will be considerably in excess of those which come from a field of mixed and deteriorated types. The grade and yield of cauliflower are seriously affected by the influence of the seed strain.

Some fields produce poorly because of too many unproductive spaces where there are skips of plants in the rows. This is generally caused by careless transplanting, unfavorable soil and weather conditions at the time of plant setting, and also by insect injury.

Plants sometimes vary greatly in vigor of growth thus markedly affecting the size and grade of the heads. There must be uniformity of good plant vigor over the entire area in order to secure high yields. Soil fertility and moisture are contributing factors in this case.

Insects and diseases frequently reap a heavy toll of plants, greatly reducing the yield. As a general rule the pests affecting cauliflower are controllable without a great deal of difficulty.

Weather conditions during the seasons of growing and harvesting often seriously interfere with the production of the largest yields. Drought reduces plant size and vigor, unusually warm weather or frost may be instrumental in spoilage of heads, creating a condition where the grower cannot harvest a maximum number of heads in their best stage of maturity.

Yields are no better than market conditions will permit. Cases are not unknown in which only a certain portion of a crop was profitably cut due to unfavorable market prices. Instead of a possible yield of 300 crates or more only 100 crates per acre may have been the actual production.

In order to more accurately estimate the yield of a certain area, this is commonly stated in terms of number of packed containers or in number of dozens of heads per acre. Suffolk County, Long Island, reported an average yield per acre in 1926 of 315 crates. In California yields vary from 350 to 400 crates (high) 175 to 225 (aver-

age) down to 100-150 crates (low). Growers in Colorado report 300 to 400 crates per acre. In Oregon average yields run between 250 to 500 packed crates per acre. In one field where the crop was very uniform, well cared for, and the heads were larger than usual, 600 crates per acre were obtained. The percentage of number 2 grade crates per acre will average in good fields as low as 3%.

Cost of Production and Marketing

Cost items, both individually and totally, vary considerably, largely according to the extensiveness or intensiveness of production, kind and price of labor, materials, soil types, manner of performing various operations, efficient equipment, length of hauls, and other factors.

Certain costs are more or less stable. Seed costs should be somewhat similar unless the direct seeding-in-the-field method is used. Plant growing costs are usually not very dissimilar even though extra costs are involved in insect control and fertilizer. Cultivation costs are generally about alike. Certain supplies for marketing, such as twine, crates, etc., are fixed.

Variations in production costs, however, occur in such items as land preparation, due to the differences in soil types; fertilizer applications which are exceedingly variable; plant setting in which methods vary, thus affecting costs; irrigation—used or not, as the case may be; insect

control necessities, which vary considerably; operations in preparing for harvesting and marketing such as tying, cutting, packing, trimming, and hauling, all of which necessarily vary with the different production areas and the individual growers in them.

Cauliflower growers commonly give estimates in terms of cost per packed crate delivered at the cars or at the local market destination.

The following examples of disbursements and receipts serve to show variation in cost items:

TABLE VII.—CAULIFLOWER GROWING AND MARKETING—ONE ACRE

Disbursements of Grower Number 1—1927

Rent of land	$ 35.00
Fertilizer—sulphate of ammonia and cost of applying	18.50
Manure—residue from previous crop manuring	6.00
Seed (direct seeding method used)	24.00
Sowing	4.00
Thinning and transplanting	30.00
Cultivation	35.00
Harvesting	75.00
Marketing	60.00
Total	$287.50

Receipts:

660 doz. at $1.60 per doz.	$1056.00
Net receipts	768.50

The above figures represent the operation costs of a grower intensively producing cauliflower on a comparatively small acreage.

Disbursements of Grower Number 2—1927

Land investment (on basis of rent)	$20.00
Soil fertilization	20.00
Soil preparation	15.00
Seed	$6.00- 9.00
Seeding, plant growing, and preparation for field	28.00
Planting (hand)	$10.00-12.00
Planting (machine)	3.00- 4.00
Cultivation and hoeing	15.00-20.00
Tying heads	25.00-30.00
Harvesting (on basis of 300 crates)	3.75- 5.00
Crates	36.00-42.00
Packing	9.00-10.00
Hauling (variable)	10.00-12.00
Selling Costs	35.00-40.00
	$202.75-$267.00

Receipts:

300 doz. at $1.25 per doz.	$375.00
Net receipts	$172.25-$108.00

The above figures represent the operation costs of a grower more or less extensively producing cauliflower in a district from which carloads are shipped.

OPERATING COSTS OF AN AVERAGE ACRE OF CAULIFLOWER
(Los Angeles County, California)
By F. H. ERNST

COST OF THE CROP:

1. Nursery costs for 1 acre of field planting, 1/5 lb. of seed	$ 5.00
Preparation of seed bed (30′ x 150′)	1.00
Weeding, cultivating, etc.	1.00
2. Pulling and transplanting in field	10.00
3. Field plowing	4.00
4. Furrowing	1.00
5. Irrigating and cultivating (5 times) (Twice with double row cultivator and once with single cultivator.)	9.00
6. Fertilizer	30.00
7. Cover cropping (once every 2nd year)	10.00
(Yearly charge)	$ 71.00

HARVESTING: (Cut 3 to 6 times)

1st picking—4 men, 10 acres, 1 day	$ 16.00
2nd picking—4 men, 10 acres, 1 week	96.00
3rd picking—4 men, 10 acres, 1 week-10 days	96.00
Balance of picking	50.00
(Harvesting costs in proportion to yield, rapidity of ripening, etc.)	$258.00
Per acre costs	$ 25.00

YIELDS—300 to 500 pony crates. Large sizes increase yields.

Average costs, in Los Angeles County, not including interest on investment, land rental which averages $15.00 to $20.00 per acre for the crop, double cropping, or taxes, $96.00.

Following is the account of grower x who had all charges of his association placed against him. (6 acres)

Twine	$ 20.80
Seed	21.00
Nails	10.35
Crates	329.43
Fertilizer	81.21
Interest	3.35
Labor	364.90
Cartage	93.80
Reserve Fund—Loans	130.32
Paid by check	1,119.45
	$2,174.81

$2,174.81 represents the value of the 2,680 crates sold by the grower, or a gross average of $362.47 per acre.

IX

CROP MOVEMENTS

The movement of cauliflower from different sections of the country is determined by the location of the growing areas. Weather conditions always play some part in forwarding or retarding crop movements, sometimes to the benefit of a shipping section but at other times acting as a serious menace to favorable marketing. As a general rule, however, each section ships at a specified time during the year with the result that, except for a short period, chiefly in the warmer season, cauliflower is found rolling to market from one production area or another.

TABLE VIII.—CAULIFLOWER SHIPPING SEASONS BY STATES

DISTRICT	*Season Begins*	*Peak Shipments*	*Season Ends*
California (N. D.)	Nov.	March *	April *
California (C. D.)	Sept. 1	Jan.-Feb.	June 15 *
California (S. D.)	Oct.	Jan.	April *
Colorado	July 15	Sept. 15	Oct. 30
Long Island	Sept. 25	Oct.-Nov.	Dec.
New York (Deleware Co.)	Aug. 1	Sept. 15	Nov. 15
New York (Erie Co.)	Sept. 25	Oct. 20	Dec. 1
New York (Catskill Mt.)	July 15	Aug. 15-20	Sept. 15-20
New Jersey (early)			
New Jersey (late)	Nov.		Dec.
Oregon	Sept. 25	Oct. 15-20	Nov. 25
Utah	Aug. 15	Sept. 25	Nov. 15
Virginia	May		June
Washington	July 1	Sept. 10	Oct. 15

* Includes Broccoli shipments.

Of the total amount of cauliflower and broccoli

grown in California, the leading shipping state, approximately 69 percent moves to market during the period of from January to April inclusive, the monthly percentages being as follows: January 22 percent; February 21 percent; March 16 percent; April 10 percent. The second period of heavy movement occurs during November and December, 16 percent of the crop being shipped during the latter month.

If the shipments of cauliflower are calculated to begin in May and end in December, the total for California would be 3,900 cars. The shipments of broccoli during the period of from January to April, inclusive, of the same year total 5,824 cars.

TABLE IX.—UNLOADS OF CAULIFLOWER AND BROCCOLI IN THIRTEEN CITIES *

	Total number carloads		*Sources of supply*
CITY	*1927 cars*	*1928 cars*	
Atlanta	44	48	Calif., Ore., Colo., Utah, N. Y.
Boston	202	426	Calif., N. Y., Colo., Ore., Utah
Chicago[1] ..	1,609	2,335	Calif., Colo., Ore., Utah, Mich.
Cincinnati ..	189	232	Calif., Colo., N. Y., Ore.
Denver	75	87	Calif., Ore., Colo.
Kansas City	172	179	Calif., Colo., Utah.
Los Angeles.	8	13	Calif.
Minneapolis	50	67	Calif., Ore., Colo., Utah.
N. Y. City.	2,030	2,739	Calif., Colo., N. Y., Ore.
Philadelphia	712	873	Calif., N. Y., Colo., Ore.
Pittsburg ...	211	280	Calif., N. Y., Colo.
St. Louis ...	325	395	Calif., Colo., Ore., Utah.
St. Paul ...	17	16	Calif., Ore., Wash.
Total	5,644	7,690	

* Information furnished by the United States Department of Agriculture, Bureau of Agric. Economics. [1] Arrivals.

X

SEED VARIETIES AND STRAINS

THE greater part of the commercial acreage of cauliflower is planted from imported seed, chiefly from Denmark. Reports from the U. S. Department of Commerce show the following figures:

CAULIFLOWER SEED—IMPORTATION FOR CONSUMPTION

YEAR	*Importation in pounds*	*Value*
1923	13,994	$90,352.00
1924	13,754	83,345.00
1925	18,291	118,530.00
1926	21,883	137,906.00
1927	16,643	106,441.00

Present import duty on cauliflower seed according to the Tariff Act of 1922 is 25 cents per pound.

With unusually favorable climatic conditions prevailing, seed growing in Europe begins by carrying the plants over the winter in 10-inch pots in greenhouses and transplanting them in the spring from which point they are grown on to seed production.

A comparatively small amount of seed is produced in California and New York in which case recommendations are made that only selected heads of the true type of the variety be allowed to develop. As the plants come into bloom they should be covered with cheesecloth or a muslin cage in order to keep out the insects that might cross pollinate the flowers with pollen of other

members of the cabbage family. When the pods are brown in color the plants are cut and laid on large canvas sheets to dry, the seed later being rolled with a large iron or wooden roller or threshed out with a flail.

Variations in Seed Strains

There are numerous points in which seed strains of presumably the same variety show variation. Strains of Snowball as well as of other varieties differ in habit of growth, season of maturity, plant characters such as size and appearance of outside leaves, self-protecting habit of jacket leaves folding over the head, and the quality of the head itself which affects the amount of grading necessary.

Eight strains of Snowball were included in a recent test for the purpose of contrasting the season of maturity, total yield, and the quality of the curd. The following table record the data obtained.

Table X.—Variations in Grade of Heads of Different Strains of "Snowball" Cauliflower

	Total No. Heads		*Percentage of Heads*	
Strain No.	*Grade 1*	*Grade 2*	*Grade 1*	*Grade 2*
1	178	83	68	31
2	211	63	77	23
3	191	81	70	30
4	212	39	84	15
5	204	80	71	28
6	198	71	73	26
7	172	95	64	35
8	197	59	76	23

Strain 4 showed a positive superiority in producing the largest percentage of No. 1 grade heads. Based on the results of these trials this strain is now being widely planted and is giving excellent satisfaction.

Snowball—The most popular variety of cauliflower grown. There are many strains of this well-known sort with a number of synonymous names. A true strain of Snowball has the following characters: Plants medium to large, erect, of fairly compact growth 24 to 30 inches high, when fully grown touching in and between the rows; stem short, 6 to 8 inches; outer leaves numerous, 10 to 12 inches wide, 28 to 36 inches long, color dark grey green with prominent white midrib or central vein, leaves slightly rolled; head, when fully developed for harvesting, compact, globular, white, six inches in diameter, fine grained, head or jacket leaves (18 or 20) well curved over head for protection of curd, weight of head with trimmed jacket leaves 3-5 pounds; number of days to maturity (approximately) 110; introduced by Henderson in 1878; synonymous names, Early Snowball, Earliest Snowball, Catskill Snowball, Mt. Hood Snowball, Snowstorm, Perfection, Success, Gilt Edge, Iceberg Snowball, Burpee's Best Early, etc.

Early Dwarf Erfurt—An early and valuable type used particularly for the spring crop as well as for frame culture and sometimes for the late crop. Plants are vigorous, medium large, sturdy, compact in growth; stem short; leaves

oblong, scarcely undulated, color light greyish green; head compact, white, fine grained, quickly forming, keeps firm for long time, has violet tint if exposed to sun; similar in many respects to an early strain of Snowball. First listed in U. S. as Earliest Dwarf Erfurt by B. K. Bliss in 1866.

Danish Giant Dry Weather—Extremely hardy strain of cauliflower, withstanding dry weather better than other sorts. The large white heads are heavy and compact, maturing a week or two later than Snowball and throughout a longer season. The leaves are quite tall and somewhat self-protecting. Valuable for higher ground. Synonyms—Dry Weather, Danish Giant, Easy Blanching.

Veitch's Autumn Giant—Often known as Autumn Giant. A hardy, tall growing cauliflower making extra large white heads. The leaves are dark green and being extra long can be easily tied or broken over the heads to protect them. They stand handling and shipping better than some other varieties. Remarkably vigorous and thrifty and useful for season of November and December where fall weather permits.

Algiers—An extremely vigorous-growing variety. Leaves very large, undulated, almost crimped, of a very dark green color; stem thick, stout, and longish; head quite large, white but not as compact as Snowball.

Pearl—This variety with varying strains of early, medium, and late, is largely used in California. The early and medium strains in general

are large plants with large, very broad, and considerably waved leaves. The color is usually a rather bright green. The curd is very white and well protected. Plants of medium Pearl often grow 4 feet tall with leaves 3 feet long by 15 to 18 inches broad. Introduced in 1900 by Aggeler & Musser Seed Co.

PART II

BROCCOLI

BROCCOLI

I

HISTORICAL DEVELOPMENT

Broccoli, like cauliflower, is a cultivated variety of the wild cabbage indigenous to the chalk cliffs of the western European coast. Botanically, it is known as *Brassica oleracea botrytis cymosa* D. C. The name "broccoli" is derived from the Latin name "brocco," a shoot, and it was originally applied to the tender shoots which were thrown out by cabbage and turnips preparing to flower. These green shoots have been esteemed as an important vegetable by the Italians from time immemorial.

In other languages broccoli is known as follows: France, choux broccolis, chou fleur d'hiver; Germany, broccoli; Denmark, broccoli; Italy, cavol broccolo.

Sturtevant mentions two races of broccolis that are well defined, the sprouting broccolis and the cauliflower broccolis, of which the former was the original kind. "The growth of the broccoli is far more prolonged than that of the cauliflower," he continues, "and in the European countries it bears its heads the year following that in which it is sown. It is this circumstance that

leads us to suspect that the Romans knew the plant and described it under the name 'cyma' which Pliny mentions in one of his writings. These excerpts indicate the sprouting broccoli, and the addition of the word 'cyma' then, as it exists in Italy now, with the word broccoli is used for a secondary meaning for the tender shoots which are emitted at the close of winter by various kinds of cabbages and turnips preparing to flower."

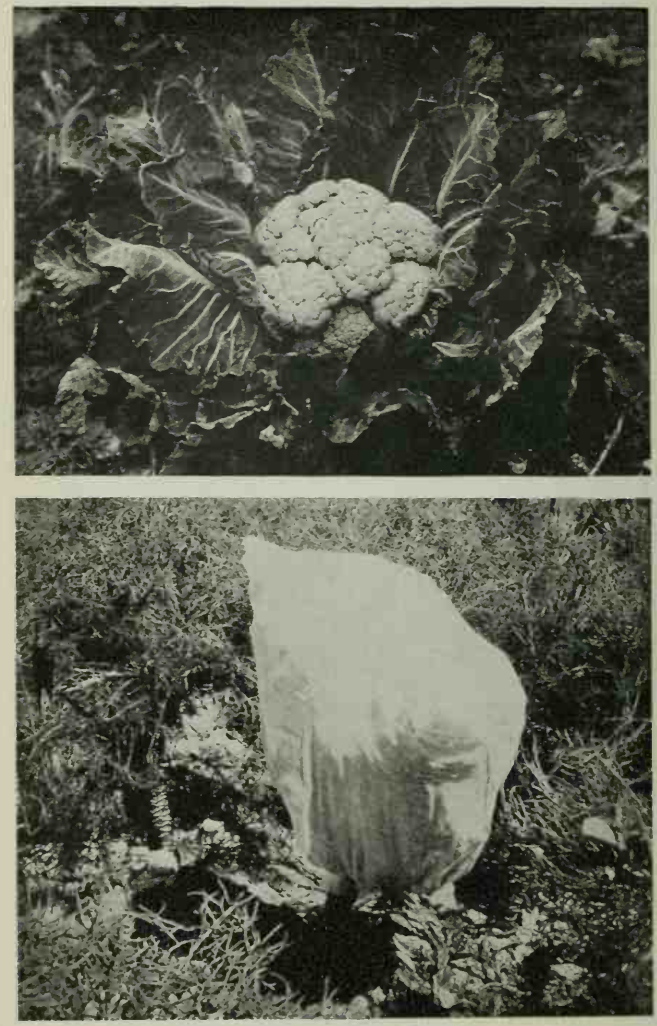
"Switzer in 1729 mentions several kinds, those with small whitish yellow flowers like the cauliflower, others like the common sprouts or flowers of a colewort, a third with purple flowers. The first and third kinds are doubtless the heading broccoli while the second is the sprouting form. These came from Italy and as the seed came mixed we may assume that varietal distinctions had not as yet become recognized and that hence all of the types of the broccoli now grown have originated from Italy."

Vilmorin's remarks concerning the development of broccoli and cauliflower have been previously recorded under the heading of the origin of the latter in Chapter I, Part I.

The further development of varieties is discussed in a later chapter on that subject.

IX. Field of Seed Strain Trials.

With both cauliflower and broccoli pre-season tests of various seed strains are desirable and in many cases practised in commercial crop production areas.



X. Broccoli Plant and Head for Seed Growing.

Above—True type of plant selected showing character of leaves and head in first stages of segmentation.

Below—Head tied for protection against crossing.

II

RELATION TO CLIMATE

Broccoli is exacting in its climatic requirements in that the plants cannot stand out of doors exposed to severe winter weather without being injured. Broccoli growing areas must be confined, therefore, to those in which the winter temperatures are comparatively mild, for the plants must successfully pass through the winter months in order to produce a crop of good heads the following spring. The average winter temperatures prevailing in any district determine whether or not broccoli can be successfully grown. Those areas now commercially producing the crop have mild winters in which severe frosts are commonly absent through the average season. Light frosts are not injurious to plants that have become gradually hardened through the fall and early winter months, but when temperatures remain around 15 degrees above zero for several consecutive days and nights, the plants are in danger of succumbing to injury thereby. Protection may sometimes be afforded by snow covering the stems of the plants, which are the most susceptible to injury, with no protection there is almost certain to be frost injury.

No extreme heat in the summer is desirable, but

normal temperatures are preferable. Fall weather conditions that permit gradual hardening of the plants in the field are superior to those in which moderately severe weather begins early in the fall. The more gradually and thoroughly the plants can become hardened to the cooler weather conditions in the fall and early winter, the more ably they can withstand the climatic conditions prevailing later on.

Spring weather conditions that are balmy and moderately warm in February and March are ideal for broccoli in its development to a state of maturity for harvesting. Excessively early warm weather in the spring is not desired, as it hastens maturity too rapidly and encourages too prompt development of the heads which make it difficult for the grower to cope with the situation of getting the heads harvested in their optimum condition. On the other hand, cold, backward, spring weather retards head formation and often tends to produce a type of head that is undesirable and inferior for shipment.

Cool weather for plant setting is valuable in enabling the plants to quickly recover and become established.

Heavy rainfall occurring during the winter months in some broccoli sections may be injurious, particularly in causing the soil to become clogged and water-logged. Ample soil drainage, therefore, is necessary as emphasized in the following paragraphs.

Soil Requirements

In view of the fact that broccoli plants must stand through the winter exposed to more or less unfavorable weather conditions, it is quite important that the selection of soil for the crop include the consideration of (1) good drainage and (2) protection from severe, driving, cold winds.

A high water table during the winter affects the roots and the stems, wherein rotting takes place. Plants which have to stand in the wet soil will usually break down sometime during the winter, eventually dropping their leaves and showing a general collapse. Sloping land, therefore, is preferred as it sheds the winter rain and drains off the excess moisture more rapidly in the spring, during which time considerable tramping of the soil is necessary in havesting. Good drainage also promotes better soil aeration and a more rapid growth of the plants and heads in the spring season previous to harvesting.

Land that is protected from cold winds during severe weather is more suitable than that which lies open and bleak. Natural windbreaks are important.

While various types of soils are used for the growing of broccoli, the principal requirements are that they be reasonably fertile, particularly well drained, and hold moisture well during the late spring and summer. Sandy and silt loam

soils are preferred for their usual good drainage. When not too fine in texture they hold moisture well. The soil must be reasonably free and friable, as there is considerable soil tramping during harvesting operations. Upland soils, usually of a clay loam nature, are satisfactory provided they are sufficiently sloping to be well drained and are in a good state of fertility. These soils usually have a clay sub-soil which does not readily permit rapid drainage. They are more difficult to be put in good texture in the spring following the unavoidable walking over the soil in harvesting the broccoli.

In many instances broccoli is grown on the same land year after year, thus requiring a careful soil handling program that considers both the texture and the fertility of the land.

Methods of soil treatment in the field are very similar to those used in cauliflower production. It is important to note, however, that in the fertilization of the land a very large foliage growth and vigor of the plants is not desirable for their best maturity as they stand more or less dormant during the winter months.

Experiences of growers indicate that a plant of average growth, free from excessive size and succulence, develops a better dormant condition than otherwise. Soil heavily enriched by fertilizers or unusually fertile by nature may grow plants undesirably large which are more susceptible to injury by cold weather. A well balanced fertilization program, therefore, is an important

consideration for the grower, having as its object a plant of moderate size and vigor.

Fertilization of land for broccoli commonly includes the use of manure, where available, or cover crops and a balanced commercial fertilizer as suggested in Chapter IV, Part I. As in the case of cauliflower growing the question of soil fertilization is almost entirely an individual farm problem in which each grower may most satisfactorily make his own tests and draw his own conclusions.

Where broccoli is grown each succeeding year on the same ground no chance for rotations is possible, otherwise vetch and alfalfa may be used as crops in the rotation and in some cases the land is summer fallowed. A practice that is sometimes followed is the sowing, in the early fall, of seed of a cover crop broadcast between the rows of plants which will eventually form a matting on which the grower walks in harvesting the crop and which adds to the organic matter of the soil when plowed under.

Little experimental data are in evidence showing the effect on the plants of a spring fertilization of the soil with a quick acting fertilizer such as nitrate of soda or sulphate of ammonia, applied previous to the harvesting season. Such materials might prove to be of value in fields that show lack of vigor and signs of producing undesirably small heads.

Super-phosphate is used in some growing areas where it is believed to be particularly beneficial

in developing a more mature plant for fall and winter dormancy and greater resistance to cold temperatures.

It is not always true that plants of average to large size are necessary for production of heads of the best market size. Strains of broccoli vary in size of plants and a good sized head may be borne by a small plant but, as a general rule, the plant must be well up to the average in growth to produce a desirable head.

It is very certain indeed that broccoli cannot be successfully grown on "run down" land or soil that has been constantly cropped without any return of plant food and organic matter. At least the instances when this would be true are few and far between.

III

PLANT GROWING AND TRANSPLANTING

THE growing of broccoli plants is not very dissimilar to that of cauliflower plants, and many of the details in the actual production of the plants are in common. One of the outstanding differences, however, lies in the fact that whereas the cauliflower plant should not reach a stage of development where it is tough and rather woody, previous to field planting, the broccoli plant is not injured when it develops a strong, tough, rather woody tissue previous to being set in the field.

In selecting an area for plant beds, it is important that a piece of ground be chosen that is naturally fertile and will grow good plants. In order to do this, the soil must hold moisture sufficiently well during the months of the growing season, namely, in May, June, and part of July, in the Western broccoli growing area. In a general way, the soil types suitable for growing good cauliflower plants will likewise produce excellent broccoli plants.

The amount of seed used per acre and the methods of seeding are similar to those discussed in Chapter V, Part I. Seeding takes place usually six to seven weeks before transplanting is desired.

The growers in Oregon sow seed during late April and through the first two weeks in May. California seedings usually occur from June 20 to August 15. If no irrigation facilities are available, seed is usually planted slightly earlier than where irrigation is possible, for plants grown without irrigation take slightly longer to develop to the stage when they are ready for field setting than those which are irrigated.

It is generally conceded that it pays to give the plants plenty of room in the row in order to permit them to grow strong and vigorous. A rather tough, woody plant is desired for field setting.

Some broccoli plant beds are watered by one method of irrigation or another. Several of the Western broccoli growers use the overhead type of irrigation, which is operated primarily to provide water for the growing of plants, in case weather conditions are unfavorable for good seed germination, and to promote a steady growth of the plants. The overhead system consists of pipes with nozzles drilled every three or four feet, through which water is pumped at an average pressure of 25 to 35 pounds per square inch, the water coming through the nozzles and breaking up in the air in the form of a fine spray. In drier seasons during early May, and sometimes later on, the water is of considerable advantage in keeping plants growing steadily, but there are also dangers when water is used that the plants may become too succulent and soft so that they

will not stand up as well when transplanted in the field. Other growers use the furrow irrigation method in the same manner as in growing cauliflower plants. Those who irrigate their plant beds usually make it a point to cut down on the watering before the time when the plants are almost ready to go into the field, in order that they may acquire more toughness and be in better condition to stand the operation of transplanting.

In many cases no artificial watering facilities are provided, but the grower relies on a piece of ground for growing his plants that has a natural capacity for holding moisture.

Good cultivation of the plant bed is necessary in order to maintain soil moisture and to keep the young plants making a steady growth. It is usually best to grow a surplus number of plants in order to have an ample supply for setting in the field. There is usually little trouble in getting rid of extra plants that are not needed for transplanting.

In about six to seven weeks plants are usually large enough to be transplanted to the field, and at that time they will be about 8 inches high, with a stem which is about the diameter of a pencil.

Methods of control of pests that attack broccoli plant beds are similar to those used for cauliflower.

Trimming Plants for Field Setting

An important operation before the plants are set in the field is to remove some of their leaf surface in order that they may withstand the shifting from the beds to the field with the least possible wilting and check. After the plants have been carefully pulled or dug up, according to the type of soil in which they are growing, a good sized handful of plants can be laid on a block of wood or on the workbench and the larger leaves severed with a sharp knife, leaving the stems of the leaves and the crown of the plant in the center intact. The leaf surface, therefore, is reduced to a very small amount and there is little danger of the plants wilting if they are set in a soil that is reasonably moist.

Mudding the plants, previous to taking them to the field, is a common practice with growers of broccoli. This consists of dipping the root system in a bucket of soil, to which water has been added so that it makes a thin mud or paste. Following the mudding it is well to keep the plants protected from the sun by wrapping them in a moist gunny-sack or by putting them into a container which is covered, so that they can be quickly handled and set out by one method of transplanting or another. Dipping the tops of the plants for lice and worm control would be the same as for cauliflower plants.

Transplanting

Success in transplanting plants to the field is affected largely by observing the following points: (1) Taking advantage of favorable weather conditions, cool, cloudy, or rainy, (2) using strong, graded plants, rather than taking, for transplanting, each plant as it comes from the bed, (3) having the soil well pulverized, mellow, yet fairly firm, with the moisture not far from the surface but well covered with a light mulch, (4) setting plants at uniform distances in the row, (5) careful transplanting as regards depth and firming of the soil about the roots.

Weather prevailing during the transplanting period may be quite dry, and it will make a great deal of difference in the readiness with which the plants stand up after they have been transplanted if they are set under conditions already named. If the smaller plants in the beds are discarded and only the strong plants used, and these carefully trimmed, there should be few skips in the rows after transplanting is completed. The most successful broccoli growers are those who spend a good deal of time in going over their ground previous to setting the plants in order to maintain the desirable soil mulch which will prevent the evaporation of moisture. Uniform spacing of plants is most important, in order that they may make an even growth and have ample room for development. Hasty work in transplanting will

show considerable difference between the distances of plants in the row. Sometimes plants may be seen in a field that are 18 inches apart, then again there will be a skip of 24 to 30 inches, and sometimes as much as 36 inches. With careful operators, however, it is possible to set the plants at uniform distances apart in the row.

Planting distances are usually 30 inches between plants and 36 inches between rows. Care in setting the plants deeply will assist in eliminating tall stem broccoli, which is undesirable as a greater degree of stem is susceptible to frost injury. Too close setting of plants is also responsible for an undue height of the plant. Some strains of broccoli, however, particularly the inferior types, are naturally long stemmed, the best types being short-stemmed.

Actual methods of transplanting plants to the field are in the main similar to those for cauliflower. Plants of sprouting broccoli are usually set more closely than the cauliflower broccoli. Spacing of 18-24 inches between plants and 24 inches between rows are common.

IV

PREPARATION FOR MARKET AND MARKETING

Blanching—Complete protection from light and unfavorable weather conditions must be given the small white broccoli head and, therefore, as with cauliflower, some means of covering the curd is necessary. Most good types of broccoli are self-protecting and the practice of putting two or three of the larger outside leaves over the head seems to furnish sufficient protection. These leaves are broken off from the lower part of the plant and laid over the head when it is small. Little, if any, tying of leaves is done such as in cauliflower fields.

Variable weather is liable to occur during the season when broccoli is heading, and when the days are warm special vigilance is necessary in preventing the heads from becoming too fully developed before they are harvested. In a short time after covering the heads, therefore, they will be ready for cutting. The leaves over the head can be quickly pulled aside for inspection of the development of the head.

Harvesting and Handling—The season of harvesting broccoli is largely determined by the earliness or lateness of the spring season as well

as by the strain used and the district where the crop is grown. Few spring seasons are alike but each year the development of the curd is materially affected by the prevailing temperatures. A gradual formation of the head under normal temperatures is desired without extremes of heat or cold. The "quality" of the head is often considerably affected by the weather conditions prevailing during harvesting season.

Practically all of the principles and the practices of successful harvesting and handling of broccoli are similar to those of cauliflower discussed in Chapter VII. If the importance of any one practice should be again emphasized it is that of cutting the heads at an early stage of maturity when the broccoli is compact and unsegmented. While the size of heads is determined by other factors as well, yet the time of harvesting can also be made to have a definite bearing on the size of the head for packing.

Careful handling from field to packing house is essential. Elimination of all possible danger of mechanical injury is the object of the grower who appreciates the delicacy and value of the white heads.

Containers—Inasmuch as the greater part of the broccoli moving into the market is western grown, it is but natural to find the regulation cauliflower crate being used for broccoli shipments. The size of crate commonly employed is 8½ inches deep, 18 inches wide, and 24½ inches long. The newer type of container now

used in the eastern districts for shipping sprouting broccoli is 13½ x 22 x 10 inches high, holding 18 bunches which are 10 inches long when the ends are trimmed.

Grading—Rules and regulations for broccoli are essentially the same as for cauliflower. Any variations of one point or another might be put into effect according to the decision of various shipping organizations but in the main the important features in segregating the heads into market values are similar.

Packing—A heavy tight pack of broccoli is desired. Chapter VII fully explains the important features of a good pack. Medium sized heads are desired with only sufficient foliage left on to protect the head.

Most broccoli packing is done under cover in specially provided sheds or packing houses. The packer can efficiently pack several crates at one time by having in front of him a sufficient number of crates so that packing of different sized heads may go forward as they come to him. The crates which are likely to be filled the most quickly should be placed directly in front while the crates in which smaller and larger sizes, respectively, are packed should be at the ends of the row of crates. Uniform height of packing heads in the crate is most desirable.

Car Loading—Methods of loading cars of broccoli crates are in the main similar to those of loading cauliflower. In some sections the alternate or pigeon hole method is used; in other

districts the straight loading is observed in which case cars are loaded 500 in the following manner: The first two tiers next to the bunkers in each end are loaded 7 high and 5 wide making 140 crates, the rest of the load being 6 high, 5 wide, and 6 long for each end, furnishing 360 crates or a total of 500. The same method of bunker and top icing are observed as for cauliflower.

Harvesting and Packing Sprouting Broccoli

The clusters or heads of the flower buds of the sprouting broccoli range in size from just a few buds to a diameter of two or three inches and occasionally as large as six or eight inches. The stems generally are green and the leaves and flower bud clusters are dark blue green in color.

The vegetable is considered ready for harvest and preparation for market when the buds are well developed and before the white or yellow petals of the flowers appear. It is highly important that it be harvested at this stage of development due to the fact that if allowed to become overmature the stems become tough, hollow, pithy and unsuitable for human consumption.

When the flower buds are advanced sufficiently, the harvesting method consists of cutting the thick stem just below the branches, leaves and flower bud clusters. These floral spikes are usually from 8 to 12 inches long. They are gathered into field crates and taken to central packing houses where they are packed into paper-

lined cauliflower pony or flat crates. The heads are packed with the butts toward the ends and the tips toward the center of the crate. If the heads are so short that the center does not become well filled, additional heads are placed in the middle of the crates.

In one method of packing, two layers of plants are used. When the first layer is in place a layer (about one shovel) of crushed ice is added; then the balance of the crate is filled in such a manner as to produce a good bulge when the lid is nailed. The most commonly used method requires three layers with ice between layers and occasionally a small amount of ice is scattered over the top before the top papers and lid are put into place. The pony crate will hold from four to ten dozen heads depending upon the size and amount of ice placed between the layers. In some districts the heads are tied in bunches, from four to five inches in diameter, and packed in the same manner as described above.

V

YIELDS, VALUES, COSTS, AND CROP MOVEMENTS

Factors affecting yields of broccoli are very similar to those of cauliflower. Favorable weather conditions during the spring usually permit almost an entire clean-up of the crop provided market conditions warrant such a procedure. Average production will be from 200 to 300 dozen marketable heads per acre, the strain of broccoli being a determining factor in this regard. Fields producing above the average frequently yield 350 to 400 crates (10 to 12 heads) per acre.

Values over a period of years for No. 1 grade range from 90 cents to $2.00 with the average prevailing price of $1.10 to $1.35 per Western pony crate f. o. b. shipping point. Prices are affected by various factors such as (1) extent of crop in production areas, (2) earliness or lateness of the crop in one state or another, (3) quality of the crop and pack, (4) competition of other vegetables in markets.

Production costs in areas where broccoli is extensively grown are somewhat lower than those listed for cauliflower. Blanching costs are less as well as those for transplanting plants where horse machines are used. Individual growers' estimates

vary considerably, ranging from $125.00 to $147.50 per acre.

Broccoli Crop Movements from various production areas are shown by the following table for car shipments.

TABLE XI.—CAR SHIPMENTS OF BROCCOLI BY MONTHS

	1927				*1928*			
DISTRICT	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*
Calif. N.D.	1						10	11
Calif. C.D.	249	335	726	317	719	885	1,034	474
Calif. S.D.	900	552	74	170	942	673	131	284
Texas					16	25	5	
Oregon		7	158	133		16	237	23

Shipping seasons vary according to the prevailing weather conditions. Moderately warm weather is necessary for the plants, previously more or less dormant, to begin to develop the formation of heads. Forward or backward spring weather in the production areas has a great deal to do with the time when a movement begins, the peak occurs, and the season closes. Market prices of a crop in one section are often considerably affected by the weather conditions governing plant development in another section, and vice versa.

The Oregon 1927 crop was unusually light due to high water and overflowed lands.

VI

VARIETIES AND SEED STRAINS

Broccoli varieties are generally divided into two distinct classes, (1) heading, or those which form distinct curds, and (2) non-heading, or the so-called "sprouting" broccolis. These again are subdivided.

The heading varieties, which are by far the more important, are subdivided into varieties or strains varying generally in their natural season of maturity. Variations in seasonal maturity may be brought about by selection and also by natural tendencies of the strain caused by the environmental conditions of the breeding work. In many cases, therefore, so-called varieties may be but strain differences of a common parent with sufficient variations in evidence to cause them to be individually named and classified.

Both imported and domestic grown strains are used in broccoli growing but the greatest acreage is produced from imported seed.

Some of the late cauliflowers almost verge into early broccolis as, for instance, various types of Late Pearl closely resemble early broccoli strains.

Two classes of broccoli varieties are recognized in California, the white and the black, the differentiation being based on the color of the foliage. The white broccoli has rather light green foliage

and is used for mid-winter cutting. Strains vary greatly. Black broccoli is a spring variety and more nearly resembles the St. Valentine. Most strains, however, have larger and straighter leaves, but all have dark slate-green leaves, hence the name. Most of these strains are distinctly inferior to good strains of St. Valentine, which have the same seasonal adaptation.

Heading varieties of broccoli have three classes, according to the color of head produced: (1) white, (2) greenish, (3) purplish. Of the first class the most widely grown is the St. Valentine.

St. Valentine—Plant large, vigorous, 36 inches high, branching close to ground, stem short, thereby permitting covering to prevent freezing: plant leaves three times as long as wide, averaging 27 to 35 inches by 9 to 10 inches; center midrib prominently white; color of leaves, upper side, dark bluish green, under side slightly lighter shade; head leaves or jacket showing tendency to curl over and well protect the head; curd compact, smooth, showing no division; color clear white, vertical section rounded and deep, head showing no evidence of leafiness or riciness.

The above description is of the desirable type. There are several kinds of inferior or deteriorated types among which is the "cabbage" type showing influence of cabbage cross, stem medium long, leaves light green and prominently veined, center of plant has form of cabbage head but breaking away the tight head leaves usually discloses a broccoli head, compact and white, but usually of inferior quality, ordinarily ricey.

Other inferior types also are (1) the "open loose" type with a large tall plant, head small, and unprotected by jacket leaves and (2) the "kale" type in which the plant is tall and spreading, stem long, leaves long and narrow, center of plant open and head, if produced, of inferior type and unfit for shipment.

Deteriorated forms of St. Valentine may, therefore, be found to a greater or less extent in broccoli fields, varying from plants which are almost abortive, or have no white head, through various crosses with other members of the brassica family, such as shown in the description made above.

Large White French—A vigorous-growing plant with rather numerous, long, stiff leaves of a glaucous-green color and deeply undulated on the edges; the interior leaves are well-curled over the head; head white, compact, and the variety is hardy and easily grown.

White Cape—Formerly grown extensively but now replaced by other sorts.

Purple Cape—One of the older sorts with a purplish colored head.

Green Cape—A greenish-headed variety in little use.

Late Pearl—A late strain of the Pearl variety, maturing in the early spring months.

Sutton and Sons, seedsmen of England, list several varieties of broccoli varying in maturity from autumn to May and June. Among the varieties are the following: Michaelmas White, Autumn Protecting, Superb Early White, Snow White, Eastertide, Whitsuntide, etc.

Morse, California seedsman, also lists several strains of broccoli varying in time of maturity such as Morse's January, February, March, and April respectively, maturing in the months designated by the names given.

Sprouting broccolis are becoming popular in various sections of the country and are finding considerable favor particularly in the eastern United States. They represent in a modern form the earliest types of broccoli when the latter ceased to be forms of cabbage. The flower buds may or may not become abortive, according to the variety produced, and rather thick and fleshy shoots are produced not only in the heart of the plant but also in the axils of the leaves, terminating in a small head about one inch in diameter. The shoots are produced in succession and they are gathered as they lengthen before the flowers open and are used like "greens" or somewhat like green asparagus wherefore some varieties have received the name of asparagus broccoli.

Varieties of sprouting broccolis are commonly divided into three classes (1) green, (2) white, (3) purple:

Italian Green Sprouting—Plant forms a reasonably large solid head. After the latter is cut, sprouts develop from the leaf-axes, each sprout terminating in a small head about one inch in diameter. These are cut in lengths of 8 to 12 inches and are tied in bunches of two and three.

White Sprouting—Yields a profusion of white sprouts; a most useful variety of sprouting broccoli.

Purple Sprouting—Hardy, valuable variety; cooks green; various strains.

Seed Growing

Broccoli seed can be successfully grown in districts commercially producing the crop. The curd or head forms sufficiently early in the spring to enable the plant to continue its development during spring, summer, and early fall in producing seed stalks and maturing seed.

A good broccoli strain takes a number of years to develop and maintain to a uniform type and requires considerable care in the actual operation of seed growing.

A common practice of seed growers is to set aside a certain portion of the broccoli field solely for seed, rather than to make selections here and there from a larger area. Seed growing should begin by first selecting as good a strain as can be obtained with which to grow the crop that will produce seed plants. The location of the seed growing area should be one that is naturally protected and preferably not far from the farm buildings, in case of any necessary emergency in the covering of the heads during frosty weather at night in the spring. The seed plot soil should be well drained.

As the heads in the plot reach a stage of maturity for harvesting, culling of all heads failing to measure up to the standard of the type desired is necessary and in many cases these can be disposed of through the regular channels of marketing. Only those heads that show the highest

type of curd and true plant characters should be allowed to remain.

Plate XII shows a desirable plant and head used for seed growing.

In order to provide ample room for development of the plants and for work with them, every alternate row in the seed area may be entirely harvested for market so as to leave the rows of seed-bearing plants 6 feet apart.

As the head develops and the segments begin to break up, it must be protected from frost injury. "Night caps" in the form of pieces of gunnysacking are necessary. Later on, as the seed stalks form, the plants in flower must be covered with muslin to prevent cross pollination with other cruciferous crops. Wild canaries and other birds may often do considerable damage in breaking the pods and eating the seed unless the plants are kept covered.

Broccoli seed heads are not without possible injury by diseases and insects. Aphis are sometimes troublesome but can be controlled by a nicotine spray. Diseases of the curd, mostly soft rots, are commonly brought about by insufficient protection of the head during the cool spring months with an ensuing frosting of portions of the curd.

It has generally been found advantageous to have comparatively few growers producing seed, these becoming specialists in the work, rather than to have growers in general doing their own individual selection and seed growing.

VII

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THE number of publications dealing with cauliflower and broccoli is not large. Those listed below are of value in supplementing the information contained in this book. In several instances growers can obtain publications concerning these vegetables, issued by their own State Experiment Station, giving detailed information which for lack of space cannot be included in this treatise.

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INDEX

Acreage
  by States, 21
Adaptation to climate, 27, 97

Blanching, 67, 109
Broccoli
  historical development, 95
Buttoning, 20, 45

Car loading, 78, 111
Car-lot shipments
  by States, 23
  by months, 115
Cauliflower
  as a forcing crop, 24
  for manufacture, 25
  plant and its parts, 18
Climate
  relation to, 27, 97
Commercial importance, 20
Commercial fertilizers, 38, 101
Containers, 71, 110
Costs, 82
Cover crops, 37, 101
Crop
  constituents, 33
  movements, 87
  rotations, 37
Cultivation, 30
Curd, 17

Development
  broccoli, 95
  cauliflower, 15
Discoloration, 17, 67
Diseases, 61

Drainage, 29, 99

Federal Inspection, 78
Fertilizers, commercial, 38
  amounts, 39
  application, 42
  recommendations, 40
Forcing, 24
Fungicides, 63
Fuzziness
  of heads, 28, 74

Grades, 73, 111
Greenhouse, use of, 44
Green manures, 36, 101

Harvesting, 69, 109, 112
History
  broccoli, 95
  cauliflower, 15

Icing, 22, 79, 113
Insects, 55
Insecticides, 63
Inspection, 78
Irrigation, 31

Jacket leaves, 76

Leafiness, 74
Leaf trimming, 52
Loading cars, 80

Manures, 35, 101
Manures, green, 36, 101
Marketing

cost of, 83
Maturity, 69
Moisture, 29, 99

Nutrition value
of cauliflower, 26
Nitrogen, 33, 38, 101

Origin
of broccoli, 95
of cauliflower, 15

Packing, 76, 111, 113
Pest control, 49, 55
Phosphorus, 34, 101
Pigeon hole icing, 80
Plants
digging and trimming, 52, 106
early crop, 43
main crop, 45, 103
mudding, 52
setting, 53, 54, 107
Potash, 35
Preparation for market, 67
Production costs, 83, 114

References, 122
Refrigeration, 79, 112
Relation to climate, 27, 97
soil, 28
Riciness, 75

Seed, 19
beds, 45
growing, 120
imports, 89
strains, 89
Seeding, 47
direct, 50
Shipping seasons, 87, 115
Shrinkage, 70
Soils, relation to, 28, 99
fertilization, 33, 101
management, 33
Sprouting broccoli, 112, 119

Table value, 26
Top icing, 79
Transplanting, 51
Transportation, 78
Trimming, 77
Tying, 67

Unloads of cars, 88

Values
of crops, 81, 114
Varieties
broccoli, 116
cauliflower, 91

Yields, 51, 144

In most instances the first number of the index refers to the page in Part I—Cauliflower; the second number refers to the page in Part II—Broccoli.

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